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EVERYTHING PNEUMATIC.

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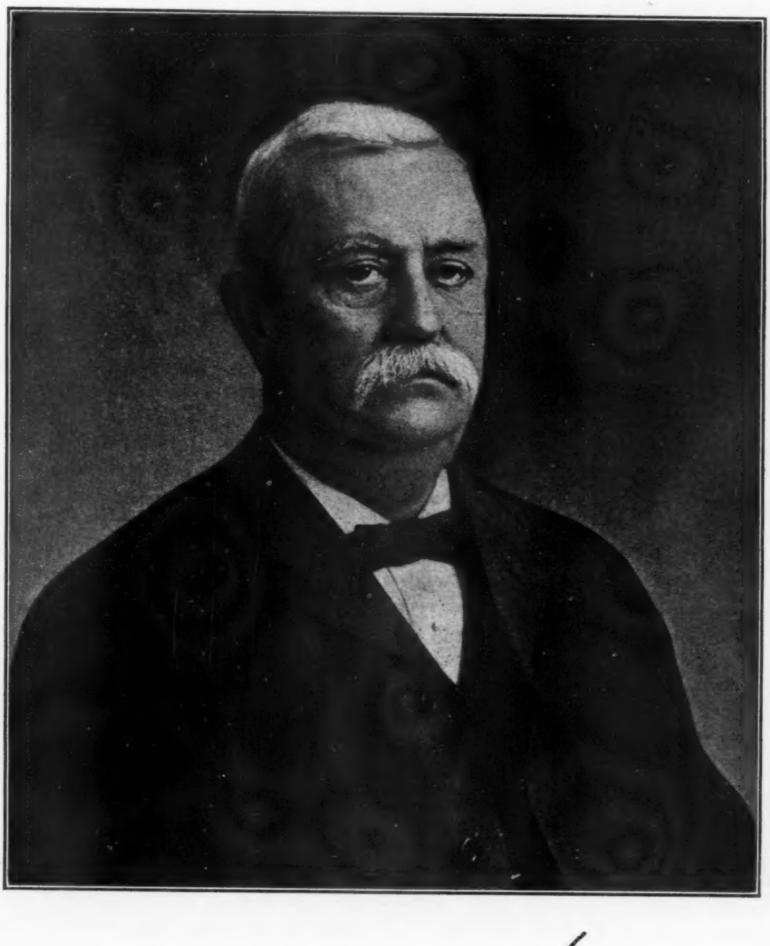


A. C. Noble

ALFRED NOBLE

Alfred Noble, one of the great engineers of America, with a record of vast experience and of a wide range of work accomplished, personally loved and honored by those who knew him, died in New York, with but little warning on April 19, just as he had completed his threescore years and ten.

The record of his life speaks for itself, and no eulogies can augment it. He was born a farmer's boy in 1844 at Livonia, Wayne County, Michigan, which was then one of the State's latest admitted to the Union. Though a pioneer State it started with a fine public school system of which the boy was a beneficiary with the rest.

The great war and the work of saving the Union, however, became for a time the paramount consideration, and in the second year of the war, when eighteen years old he enlisted in the Twenty-fourth Michigan, in which he went through the severest service. On the first day at Gettysburg his regiment lost 300 in killed and wounded out of 460 who went into the fight. He was discharged at the close of the war with the rank of sergeant, and his veteran record led the way to a clerkship in the War Department.

He was earning money and also studying, so that after a year or so he was able to enter the University of Michigan as a sophomore, and was graduated in 1870 as a civil engineer. While in college he had been earning his way by outside work, chiefly as a recorder and assistant engineer in harbor work on Lake Michigan, conducted by the U. S. Corps of Engineers, and the year of his graduation he was placed in local charge of the improvement of Sault Ste. Marie. After twelve years, which saw the completion of the great lock, he resigned and then supervised the construction of the truss bridge over the Red River at Shreveport, La.

Early in 1884 he became assistant general engineer of the Northern Pacific Railroad, and during the next three years he had charge of the building of many important bridges and viaducts on that system. Then he had charge of the erection of the magnificent Washington bridge across the Harlem River, then the largest arch bridge in the world. After that there was the erection of a great bridge across the Ohio at Cairo, a cantilever bridge over the Mississippi at Memphis and other bridges at Bellefontaine, Leavenworth and Alton.

In 1895 Mr. Noble was appointed by President Cleveland a member of the Nicaragua Canal Board. The Board examined in detail both the Nicaragua and the Panama routes, completing its work November 1895. In June, 1899, he was appointed by President McKinley a member of the Isthmian Canal Commission, charged with the selection of the best route, and that finally determined upon was practically as selected by this commission. While charged with this duty Mr. Noble with his colleagues visited Europe to examine the canals there and also made several trips to Central America.

In 1905 he was appointed by President Roosevelt a member of the International Board of Engineers to recommend whether the Panama Canal should be a sea-level or a lock canal, the board consisting of thirteen members, of whom five were nominated by foreign governments. Mr. Noble was one of the minority of five Americans who recommended the adoption of the lock plan, and it is said that the reading of a letter of Mr. Noble before a committee of Congress determined the favorable action of that body.

In March, 1907, he was one of three appointed to visit the Canal to investigate the conditions regarding the foundations of some of the principal structures. This duty was completed in a few weeks, but within that time he suggested new and ingenious devices for definitely determining the safe foundation pressures. Mr. Noble was continuously identified with the canal project, and he deserves as much credit for the solution of the engineering problems as any other one who has been associated with the work.

Other great engineering responsibilities were sandwiched in with these sketched above. In July, 1897, he was appointed a member of the U. S. Board of Engineers on Deep Water Ways, which made elaborate surveys and estimates of cost for a ship canal from the Great Lakes to the Hudson.

He was appointed with Henry C. Ripley and General Robert as a Board of Engineers to devise a plan for protecting the city of Galveston from inundation. They recommended the building of a solid concrete wall over three miles long and seventeen feet high, the raising of the city grade and the making of an

embankment adjacent to the wall, and the work was executed by him in partnership with Ralph Modjeska.

Perhaps the most important of Mr. Noble's labors, as that by which he became best known, was as a member of the board directing the operations of the Pennsylvania Railroad in tunneling under the North and East Rivers and under Manhattan and the construction of the great station on Seventh Avenue. Besides serving as a member of the board, Mr. Noble was chief engineer of the East River Division, and directly in charge of the construction of the tunnels under Manhattan and the East River, and their related terminals on Long Island. This may be regarded as one of the most difficult engineering undertakings ever successfully accomplished, although the general public had no means of realizing it.

Since the completion of that work Mr. Noble has been in general consulting practice, serving also on retainer as consulting engineer for the New York Board of Water Supply. Only last year the Federal Government charged him with an important service. The construction of a drydock at the Naval Station, Pearl Harbor, Hawaii, had come to disaster by the eruption of the bottom, and Mr. Noble was sent to advise as to how the work should be completed. He reported for the Canadian Government upon the enlargement of the Welland Canal. The Public Service Commission of New York which is building a $165,000,000 subway system also called for his services in consultation.

Mr. Noble never posed for publicity, but recognition of his abilities and of his great engineering works accomplished was inevitable, especially from those best informed and most competent to judge. His own University of Michigan in 1895 conferred upon him the degree of Doctor of Laws, the same honor coming to him from the University of Wisconsin in 1904. He was president of the Western Society of Engineers in 1898, and of the American Society of Civil Engineers in 1903. The John Fritz medal was presented to Mr. Noble in 1910. The same year he was elected an Honorary Member of the Institution of Civil Engineers of Great Britain, a distinction held by no other American. In 1912 he received the Elliott-Cresson Medal of the Franklin Institute "in recognition of his distinguished achievements in the Field of Civil Engineering."

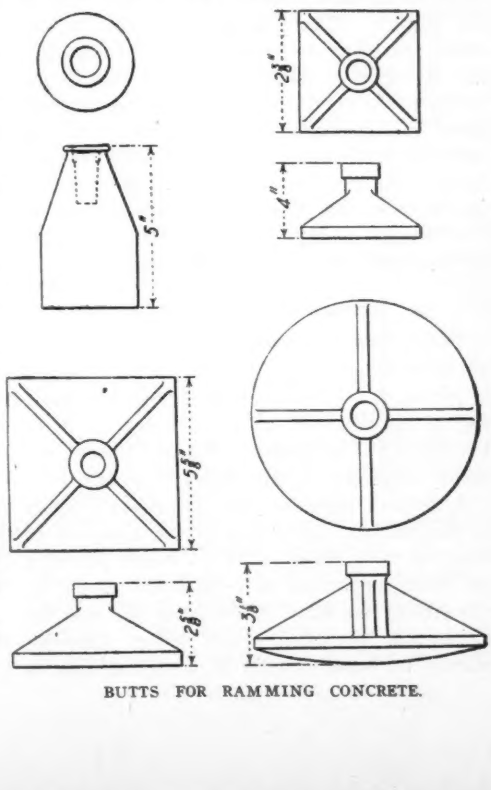
Mr. Noble was deeply interested in elevating the status of the engineering profession and took an active part in the organization of the American Institute of Consulting Engineers. He was especially kindly and helpful to the younger and rising members of the profession. He was universally respected by all who had business dealings with him, he commanded the faithful and enthusiastic loyalty of his subordinates and the sincere affection of those who came most near to him.

PNEUMATIC RAMMERS FOR CONCRETE

BY CHARLES A. HIRSCHBERG.

Pneumatic rammers are used in all up-to-date foundries for ramming molds, and have reduced labor and costs and improved the product. It is only recently, however, that they have been employed in such work as tamping earth around gas and water mains, building roads, constructing concrete buildings, making concrete pipe, artificial ashlars, steps and pillars and ramming concrete walls in tunnels.

Lower cost and greater speed are not the most important factors to be considered in this class of work. The improved quality of



BUTTS FOR RAMMING CONCRETE.

the pneumatically finished product over that rammed by hand is such that contractors, particularly in France, Germany and Belgium, are resorting to the use of the pneumatic rammer in the interests of safety and lasting attributes.

In the accompanying photograph are shown a number of Crown pneumatic rammers at work on a large concrete palace constructea last year at Nancy, France. This rammer is of the same general construction as the rammer used in foundry work, although the butt is different. In the drawing are shown several shapes of butts used for ramming concrete. The large butt is employed for general work and the small square one for working in corners and restricted areas. The round butt is used occasionally. Butts for ramming concrete are generally made of cast steel. For finishing the work and to avoid the spraying of the semi-liquid cement the butts are made of rubber, hard wood and occasionally of fiber.

The rammer is equipped with a trigger throttle by means of which its entire operation is controlled. In general construction this tool is simple; a valve of the spool type works in a hardened-steel valve box which is clamped between a cylinder and head block from which an extension tube or pipe leads to the throttle. There is also a piston, to the outer extremity of which a butt is attached. An air hose is connected at the top of the rammer. With the exception of the butt, all parts are generally made of steel. A tool such as that shown consumes approximately 24 cu. ft. of free air per minute at 80 lb. (with the throttle wide open) under which pressure it is usually operated. It strikes approximately 600 blows per minute at this pressure.

RECORDS OF PERFORMANCE.

The average performance of one rammer operated by one man over a ten-hour period is 270 sq. ft. of surface rammed. In the mak ing of big pillars it rams easily 212 cu. ft. in ten hours. The finished product is much superior in quality to that rammed by hand.

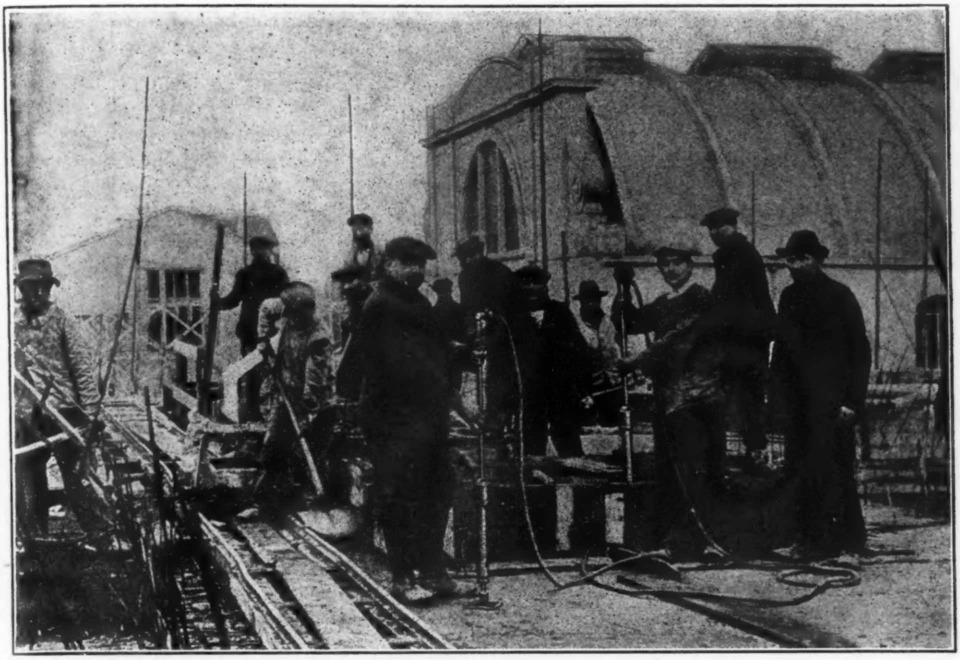
A Belgian engineer, who has made a study of this subject, found that in the ramming of concrete the number of blows struck played a far more important part than the power or strength of the blow. Such being the case the mechanical rammer, which strikes approximately six hundred light blows per minute, is ideal in comparison with hand work. In one experiment on comparatively small cubes it was demonstrated that sixty blows gave the concrete a resistance of 2,844½ lb. per square inch; forty blows, 2,460¾ lb. per square inch, and twenty blows, 1,538 lb. per square inch. A similar test with hand-ramming gave a resistance of only 939 lb. per square inch. The hand rammer used weighed 33 lb. and was permitted to fall from a height of 20 in.

Expert workmen handling the hand rammer are unable to strike more than fifty blows per minute and maintain that speed for any length of time. It was shown that the same workmen using pneumatic rammers under an operating pressure of somewhat less than 80 lb. were able to maintain a maximum of four hundred blows per minute over a considerable period. It is also possible to vary the number of blows at will, reducing them to as few as three per minute.

Further tests demonstrated that the pneumatically rammed concrete is much more dense than hand-rammed concrete and that one man and a pneumatic rammer would do approximately the work of five men working by hand. In the case of one study it was found that one man operating over a large area of concrete was able to cover 1,076 sq. ft. of surface in ten hours. Experiments conducted in the manufacture of concrete pipe in the neighborhood of Paris showed a saving of 50 per cent. in the cost of production.

As on the majority of such work, air power is a part of the contractor's equipment, for the operation of temporary pneumatic lifts, riveters, etc., the use of pneumatic rammers does not entail any outlay for temporary power plant equipment, and it would seem that the results obtained by their adoption are such as to warrant greater interest on the part of the contractor. The type of rammers illustrated in this article is manufactured by the Ingersoll-Rand Company.—*Engineering Record.*

Nitrogen over one square mile of the surface of the earth—including land and sea—is estimated to be sufficient to supply the whole world with fertilizer, at the present rate of consumption, for fifty years, and while the fertilizer was running its course, supplementary nature processes would be returning the nitrogen to the atmosphere again.



CROWN PNEUMATIC RAMMERS AT NANCY, FRANCE.

PNEUMATIC TOOLS

BY H. S. HUNTER.*

It is my pleasure to give you to the best of my ability a brief history of the origin and development of portable pneumatic tools. By "portable" I mean machines that can be conveniently carried around in the hands of the operator; I do not refer to pneumatic tools or machines of stationary or semi-stationary types. The power used to operate pneumatic tools, as the word implies, is compressed air generated by an air compressor which may be direct driven either by steam, gas, gasoline, electric motor, water power or by belt from any of these sources of power. The air pressure usually carried is from 80 to 100 lbs. per square inch. Steam cannot be used conveniently to operate portable pneumatic tools, as the temperature rise of the machine would be such that the operator could not hold it.

The air is conveyed from the compressor, or from a receiver used to overcome the pulsations of the compressor, through a pipe line to within 40 or 50 ft. of the work, depending on the radius of operation desired, and then through a flexible hose to a connection on the tool. The tool is provided with a throttle valve within the touch of the operator, which enables him to start and stop the machine without releasing his hold.

Pneumatic tools may be divided into two classes: the percussion motor, or what is commonly called the pneumatic hammer, and the rotating motor, commonly called the pneumatic drill or reamer.

As is the case with a great many of our modern labor saving devices, we owe the original idea of portable pneumatic hammers to England, but it rested with us to develop this idea and put it into practical use. The original pneumatic hammers were used for filling teeth. They were known as pneumatic dental pluggers, and to this day are used by a great many dentists for this purpose. From the miniature dental pluggers of 30 or 40 years ago the present portable pneumatic hammer has been developed.

It is rather difficult to convey in words the mechanical principles employed. You can imagine, however, an air gun, the bullet of which would correspond to the piston of a pneumatic hammer. Suppose we place in the forward end or muzzle of the gun the shank

*From a paper before the Fellows' Club, Pittsburgh.

or end of a piece of steel which is provided with a shoulder that will allow it to enter the muzzle only a given distance, the opposite end of the steel is dressed or machined to suit the work we wish to do. In the case of driving rivets the steel would be cupped to form a rivet head. If we wished to chip or cut iron or steel we would shape the forward end of the steel like a chisel and so on for any work, such as beading flues, calking boilers, carving marble, stone, etc. The operator places the forward end of the steel against the work and presses the trigger or opens the throttle valve, and holding it open, the piston is projected forward in the cylinder striking the shank of the steel. The instant the blow is struck the piston is returned to the rear of the machine for the next stroke. This forward and return movement of the piston is controlled by an automatic valve placed in the rear of the cylinder, the valve in turn being actuated by the piston through communicating air ports. The number of blows struck per minute ranges from 400 to 11,000, depending on the size, length of stroke and type of tool.

A fertile field for the use of pneumatic hammers in their early stages was calking the seams of steam boilers and other vessels built to withstand pressure. Before the introduction of pneumatic hammers no mechanical means were in use for this purpose, and the average day's work of 9 hours for a man was about 85 lineal feet, while 390 ft. is not an exceptional day's work with a pneumatic calking hammer.

Two hundred and fifty rivets per day was considered a fair day's work for a crew of 3 men and a rivet-heater boy, while 2,000 rivets are being driven per day by a crew of 2 men and rivet-heater boy with a pneumatic riveting hammer. Besides, considerable skill is required to drive a tight rivet by hand, while only ordinary intelligence is required to apply the pneumatic hammer.

Portable pneumatic motors or drills are a modern adaptation of the steam engine, differing only in application. They are built in three types, the reciprocating piston, the rotary and the turbine principles being used; the former, however, seem to have the preference, due no doubt to the more compact form possible with this principle. They are designed to develop the maximum power with minimum weight and to meet the specific requirements for which they are built.

miniature engines can be had when I tell you a miniaturt engines can be had when I tell you a pneumatic drill weighing 40 lbs. will do the work of a modern stationary upright drill press weighing 1,800 lbs., and that pneumatic hoists will lift a weight corresponling to 2,500 times their own weight one foot high in one minute with 90 lbs. air pressure. The modern portable pneumatic riveting hammer will develop power equal to 3,800 times its own weight in one minute with 100 lbs. air pressure, or a machine weighing 22 lbs. will develop 2½ H. P., and continue to develop this power indefinitely, in spite of the extreme adverse conditions under which they are sometimes used.

Some users complain of the maintenance cost of pneumatic tools, but when the enormous power developed compared with the weight of machine is considered, as well as the class of labor usually employed to operate them, there is an excuse for a somewhat higher cost of maintenance than would be the case with other types of machinery.

The pneumatic tool is perfectly satisfied to be judged by the quantity and quality of its work as compared with any other device or tool made and when final results are considered the cost of maintaining pneumatic tools dwindles into insignificance.

GAS TO BURN IN THE FOUNDRY

The gasworks in the town of Heinichen, Germany, is co-operating with a local foundryman for the utilization of gas for starting the latter's cupola furnace, etc. The necessary burner, made in the foundry itself, is used not only for lighting up, but also for core-drying, mold-drying, and the like; no other means being employed. To know how much gas is used, and to prevent unnecessary consumption, there is attached to each burner a "penny-in-the-slot" meter. For lighting the cupola once, there is required 1,800 liters (64 cu. ft.) of gas, which at the regular price of 17 pfennigs per thousand liters ($1.11 per thousand cu. ft.) costs about 30 pfg., or seven cents. Lighting the driers costs about two-thirds as much. The saving is not only in the cost of the materials used in combustion, but also in time required for splitting the wood, and the like; and there is no more complaint from the neighbors on account of smoke.

THE GANG AT THE HEADING.

A RECORD OF RAPID TUNNEL DRIVING

BY FRANK RICHARDS.

The tunnel here to be spoken of, recently completed, constitutes an important addition to the waterworks system of St. Louis, Mo. It extends from the existing pumping station at Chain of Rocks on the Missouri shore of the Mississippi to an intake near the Illinois shore of the river. There is of course a shaft at each end of the tunnel and another close to the river bank from which the tunnel was driven in both directions, 537 feet of it being under the land and 2252 feet under the water, although the rock is practically the same from end to end, a hard limestone, which drills well, except for the fact that it is full of horizontal seams, which makes it extremely blocky.

The working shaft was 96 ft. deep, 32 ft. in earth and the remainder in rock. It was circular, 12 ft. diameter in the earth and 10 ft. diameter in the rock. The tunnel, 10 to 11 ft. diameter, was driven as a single heading in each direction from this shaft. There was left 1.5 to 2 ft. of loose muck in the bottom of the tunnel for all of the work except the last 600 ft. of the river tunnel where the bottom was raised slightly to pass over a water seam. Even then, however, about 3 ft. was left in the bottom, of which about a foot was hard rock.

Both headings were driven at once until the shore tunnel was finished, after which one heading was continued until the end. The headings were turned Sept. 26, 1913, and the 537 ft. of land tunnel was completed Dec. 17. The river tunnel was completed March 4, 1914. During the time there were several shutdowns, the longest of which was about ten days.

Four C-110, Butterfly valve, Ingersoll-Rand drills, pistons 2¾ in. diameter, were used at each heading. At first these were mounted on two 7 ft. columns with arms. At that time each 8 hr. shift mucked out, set up, drilled and shot once, making 3 shots in 24 hours. Later on four shots were made in the same time: one at 8 A. M., then at 2 P. M., 8 P. M. and 2 A. M., still using the two columns.

On Feb. 21 a schedule of two shots per shift, or 6 shots in 24 hours, was started. Under this arrangement a single shaft bar was used 4½ in. diameter and 10 ft. long with four arms. The bar was set up about a foot above the spring line of the tunnel, and the entire heading was drilled from the one setting. To steady the bar a special arm was made with a jackscrew in the end of it. This was placed in the middle of the bar and the screw set up against a block below and somewhat behind the bar, see half-tones.

At the beginning of the work as many as 22 holes were used to break the ground, but this was finally brought down to 16 holes, distributed as follows: Six cut holes, three on a side, one breakdown hole above the cut, one center and two rib dry holes, and seven side-round or trimming holes. The cut holes were drilled 6 to 7 feet deep and the other holes from 4 to 6 feet.

In trimming the tunnel three Jackhamer drills were used for the sides and bottom, while the roof was drilled with a BC-20 (Butterfly) stope drill. The entire 2789 ft. of tunnel was practically ready for concrete 26 days after holing through.

DRILL SHARPENING.

There were used from 120 to 200 pieces of steel per day, and these were made and sharpened on a Leyner Drill Sharpener by one blacksmith and one helper, working on 8 hr. shift. They also attended to all general work for both the tunnel and the caisson work in the river. In the photo of the blacksmith shop the drill sharpener is in the extreme back ground, right center, while at the extreme right we see a rock drill which has been rigged up as a power hammer.

TOOL SHARPENING SHOP.

RATE OF PROGRESS.

The rate of progress at first, with three shots in 24 hours, was about 103 ft. per week of seven days, on the four shots it was 132 ft., and with the six shots it was 175 ft. or better. For the week ending 8 A. M. Feb. 20, the progress was 184 ft. or about 26.3 ft. per day. For the month ending at 8 A. M. Feb. 21 the progress was 744.7 ft. of tunnel. The figures for the monthly and weekly progress are be-

lieved to be a new record for the United States.

The best shift's work was 12.2 ft., the best day's work was 29.1 ft. and the best single shot while on the six-shot schedule was 6.6 ft. One of the drill runners in the heading drilled 42.1 linear ft. of holes in 100 minutes, and the time for drilling on entire round of about 108 ft. of holes was from 100 to 120 minutes.

The screen chamber shaft, at the land end of the tunnel, was sunk with one Jackhamer drill, which furnished muck for 8 to 12 men. On one occasion, when there was a smooth bottom to work on, the one man drilled 42.6 ft. holes and shot them in an 8 hour shift.

In this important extension of the St. Louis water supply there were other problems involved besides the driving of the tunnel, notably the building of a coffer-dam in the river and the sinking of the shaft for the intake. The entire work was handled, including the designing as well as the execution of it, by C. H. Hollingsworth as General Superintendent for the Fruin-Colnon Contracting Company. With him in charge of the three shifts were C. H. Sleight, W. B. Converse and J. M. F. Burkman, with R. E. Mosier in charge of the screen chamber work.

Mr. E. C. Davis was Resident Engineer for the city of St. Louis, and to him we are indebted for the progress data here given. One of his inspectors measured the work after each shot and the progress was minutely recorded.

DESIGNATING THE WINDS

The Beaufort scale will be used hereafter by the Weather Bureau in designating wind velocities in weather forecasts.

BEAUFORT SCALE.

Force.	*Designation.*	*Miles per Hour.*			
0	Calm	From	0	to	3
1	Light Air	Over	3	to	8
2	Light Breeze	Over	8	to	13
3	Gentle Breeze	Over	13	to	18
4	Moderate Breeze	Over	18	to	23
5	Fresh Breeze	Over	23	to	28
6	Strong Breeze	Over	28	to	34
7	Moderate Gale	Over	34	to	40
8	Fresh Gale	Over	40	to	48
9	Strong Gale	Over	48	to	56
10	Whole Gale	Over	56	to	65
11	Storm	Over	65	to	75
12	Hurricane	Over	75		

METHODS AND COSTS OF DRY DOCK EXCAVATION ON THE PANAMA CANAL

BY G. H. GILBERT.

The condition of disintegration of material that is to be excavated is the circumstance that, in the main, will determine the quantity that may be removed in a given time by a steam shovel. This disintegration of material when effected by means of explosives will result in the production of larger or smaller fragments, depending upon the geological formation, the quantity of explosive employed, the diameter, depth, and relative positions of the blast holes.

On the Panama Canal work, the greatest quantity of dry rock excavated by steam shovel was from the Central Division, which division included the great Culebra Cut, and this division will be taken as typical of the practice and methods employed on the Isthmus.

The geological formation of the Central Division consists, in the oldest rocks, exposed between Bas Obispo and Empire, of an extensive meta-conglomerate at Bas Obispo, overlain by a series of variegated volcanic agglomerates, tuffs, lava flows, plugs, dikes, and volcanic breccias, mostly of basic character. These formations are all much faulted and sheered. A 500-foot downwarp or sag, the northern rim, which is at Empire, is of breccia (an aggregate formed of angular fragments united by a matrix or cement;) the southern rim, at Paraiso, is basalt intrusions and breccias. This downwarp is not now a valley but is filled in with a land-deposited formation of very fine grained green volcanic clay, and the latter intruded by basalt and breccias. The downwarped rocks consist of dark, soft and friable, thinly bedded, carbonaceous shales and clays, containing lenses of gravel, sand, marl, and waterlain basic tuff (scoria and ashes.) This formation is estimated as 250 feet thick. It grades upward into the next younger formation, which consists of light gray, limy sandstone and sandy limestone beds and lenses, three inches to three feet in thickness, separated from each other by thin beds of friable marly shale, with considerable carbonaceous matter, locally. These formations show fossil oysters, gastropods, corals and foraminifera, all remains of a marine fauna. Pyrite occurs locally in these beds, and where there are layers of carbonaceous material it has, on ex-

posure to the atmosphere through blasting, generated sufficient heat to ignite wood.

The chief characteristic facts about these series of bedded rocks are their low crushing strength and comparative weakness, and their subjectivity to weathering and erosive processes. The last marine bed of rock is a shell and coral limestone, found at intervals across the Isthmus. Overlying most of the above described beds is a subaerial deposit, over 400 feet thick, of fine grained basic volcanic clay rock, which fills the downwarp in the marine beds.

This formation, locally, contains lenses and beds of gravel, sandstone, carbonaceous and lignitic shales in beds up to four feet thick and an extensive flow of lava twenty feet in thickness. The whole formation is very weak, crumbly, and easily weathered. This general geological description applies to the Central Division and includes all the very heavy cuts between Bas Obispo and Paraiso and comprising the Culebra and all other work on the division.

The operations during the year 1911-12 were fairly representative of the best operating conditions of excavation. During this period over 17,000,000 cubic yards were excavated from this division, of which over 84% was classified as rock. A further arbitrary classification of all rock excavated was 80% soft rock and 20% hard rock; these classifications were changed to the more general classification of blasted material. A review of the geology of the division will show the difficulties of even an approximate classification of the widely differing materials and their respective quantities.

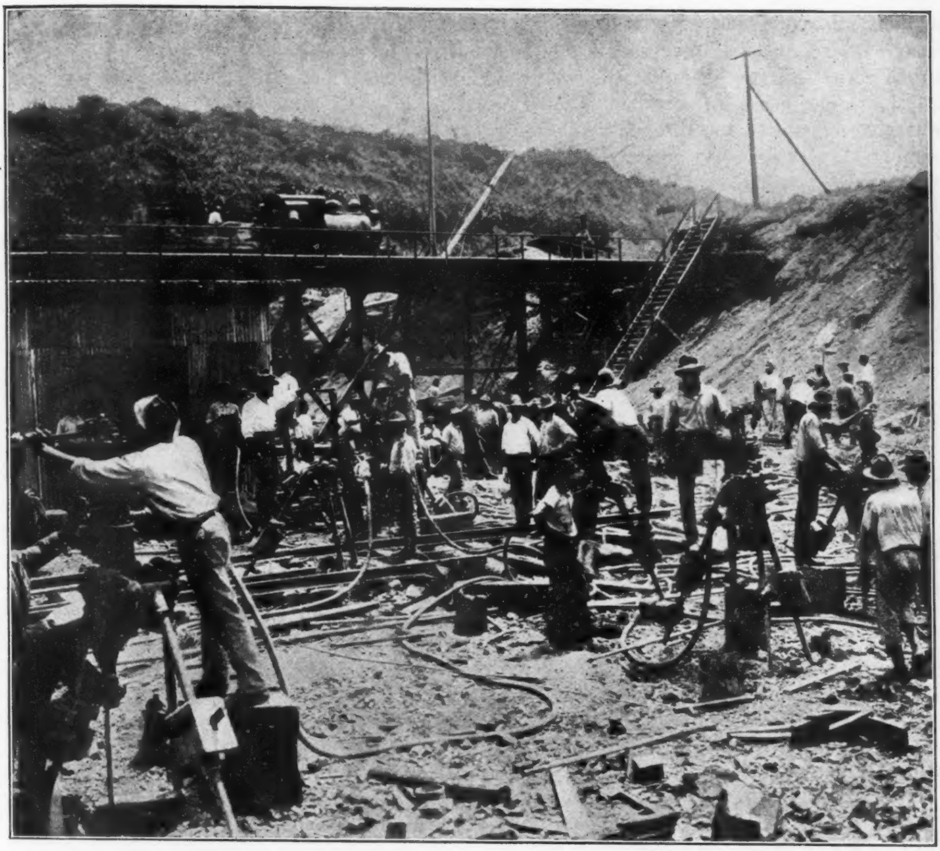
The weak and crumbly "soft rock," in its unstable condition, would be disturbed readily and dislodged into an open cut by using dynamite in the minimum quantity in blasting. The common effect of an explosion was the dislodgement of great masses of this already disintegrated material, which upon impact with the bottom of the cut would be broken up still more and be in condition to be readily excavated by steam shovel. It is in material of this nature that the abnormal quantities have been excavated by steam shovel. A record has been established by one shovel of excavating and loading 4,465 cubic yards in eight hours. This was a 95-ton Bucyrus machine. The same shovel dug the record quantity for one month of 70,290 cubic yards. Another shovel of the same size and make has established a record for a year's work of 543,481 cubic yards, the machine working 295 days. These records are no criterion of the usual performance of these machines, the records being made under the most favorable conditions that may be arranged.

During the year 1911-12 there were employed on the Central Division, 46 steam shovels of the following makes and sizes: 20 Bucyrus 95-ton shovels with buckets of 5 cubic yards capacity; 10 95-ton shovels with 4 yard buckets, 7 70-ton with 3 yard buckets, and 2 45-ton with 1¾ yard buckets. Of the Marion Co.'s make there were 7, Model 91, with 5 yard buckets. These 46 steam shovels excavated, in rock and earth, approximately 17,000,000 yards, an annual average for each shovel of 370,000 yards. The average monthly output was 33,000 yards, the daily output 1,318 yards, and the hourly output, while under steam, about 165 yards.

In addition to the advantages accruing from the use of powerful shovels with very large capacity buckets, the transportation methods and equipment for the disposal of the excavated materials, were a factor contributing to the large output of the steam shovels. Flat cars of 19 cubic yards capacity, were very generally used to transport the excavated material to the spoil banks or dumps. These cars were unloaded by means of a power operated plow or unloader. These cars were of the Lindgerwood Co.'s build. In a lesser degree, dump cars of 10, 17 and 24 cubic yards capacity were employed in filling in from trestles and other similar situations.

The large flat cars permit of very rapid loading and unloading without the common delays experienced with dump cars, of the larger fragments jamming and binding in the body and doors. The type of equipment, the large size of the cars, and the large number of cars and locomotives always available enabled the steam shovels to be kept at work without the usual serious delays caused by waiting for the removal of loaded cars or the return of unloaded ones. During 1912, a total of 12,863,000 cubic yards of blasted material was excavated from the Central Division. There were in use on the division, 150 well drills and 230 tripod percussion drills.

The formations of a soft and open nature,



TRIPOD DRILLS AT PEDRO MIGUEL LOCKS.

permitted the rapid sinking of blast holes of large diameter, by the oil well type of gravity drill. The well drills were ordinarily operated in the loose friable materials and where there was an overlay of earth, and lenses and pockets of sand and gravel. To prevent the earth, sand or gravel from filling in and blocking up the holes during the drilling process, pipes or casings of iron were driven in the hole as the bit penetrated. This added to the cost of the process. The holes drilled were 5 inches in diameter and 19 feet in depth, as an average. The average number of feet drilled per day per well drill was 50 feet at an operating labor cost of 6.68 cents per foot.

In the hardest rock, such as basalt, the igneous rocks and dikes, the tripod percussion drills were employed. The average number of feet drilled per day per tripod drill was 41 feet, at an average operating labor cost of $0.0896. In drilling horizontal or toe holes, the tripod drills were of necessity employed. To blast approximately 13,000,000 yards 5,000,000 linear feet of blast holes were drilled. The average quantity of material blasted to each foot of drilled blast hole was 2 3-5 cubic yards. The aggregate length of holes drilled by well drills and by percussion drills was about the same.

WELL DRILLS AND PERCUSSION DRILLS COMPARED.

As a basis for an adequate understanding of the comparative performances of the well drill and of the percussion drill, it will be necessary to make comparison of the mechanical performance and the useful work performed in a given time, as the work appropriate to either type is in entirely different formations and under differing operating conditions.

The function of a well drill is to sink a well

or hole of comparatively large diameter through mixed or loose formations, in which may be placed a large quantity of slow acting explosive. The holes, in accordance with the nature of the strata are drilled at comparatively great distances between centers, 15 to 25 feet as governed by the depth of cutting and the nature of the formations penetrated. The surrounding conditions most favorable to the operation and employment of the well drill are where the formations being penetrated are of an open and friable nature or where there is an overlay of earth, and where the material to be blasted is in a naturally unstable condition and requires but to be shaken or disturbed by the eruptive action of a large volume of gas resulting from the explosion of slow acting or low-power dynamite in quantity, to separate, or disintegrate the mass sufficiently to allow it to be freely excavated by steam shovels.

The work performed by a well drill is due to the action of gravity. The weight of the drill bar and the kinetic energy developed on impact with the rock, by the dropping of this bar from two to three feet, is the limitation of the mechanical work performed. The bar is raised and dropped from 50 to 60 times per minute.

The percussion drill, operated by compressed air or steam, may be obtained of any practicable power or speed and mounted on tripods or carriage, as best adapted to the conditions of the work to be performed. In hard rock, or where holes are required to be drilled at any angle, or under any circumstances where great quantities of material require to be blasted in the shortest time, the high speed percussion drill will demonstrate greater efficiency and economy than any other type.

As a comparative illustration of the useful work performed by a well drill and by a percussion drill in a given time: A well drill with a bar weighing 1200 pounds strikes 50 blows a minute, a percussion drill striking the same blow would strike from 350 to 400 blows in the same time, or, otherwise stated, would perform from seven to eight times the amount of work. In actual practice these results are achieved by percussion drills mounted on carriages and having a vertical feed of ten to twenty feet. These drills are of great power and penetrate the hardest rocks readily. The cost for labor of operatives is about the same per day, but the cost per foot of drilling is reduced proportionately to the comparative performance of either type of drill.

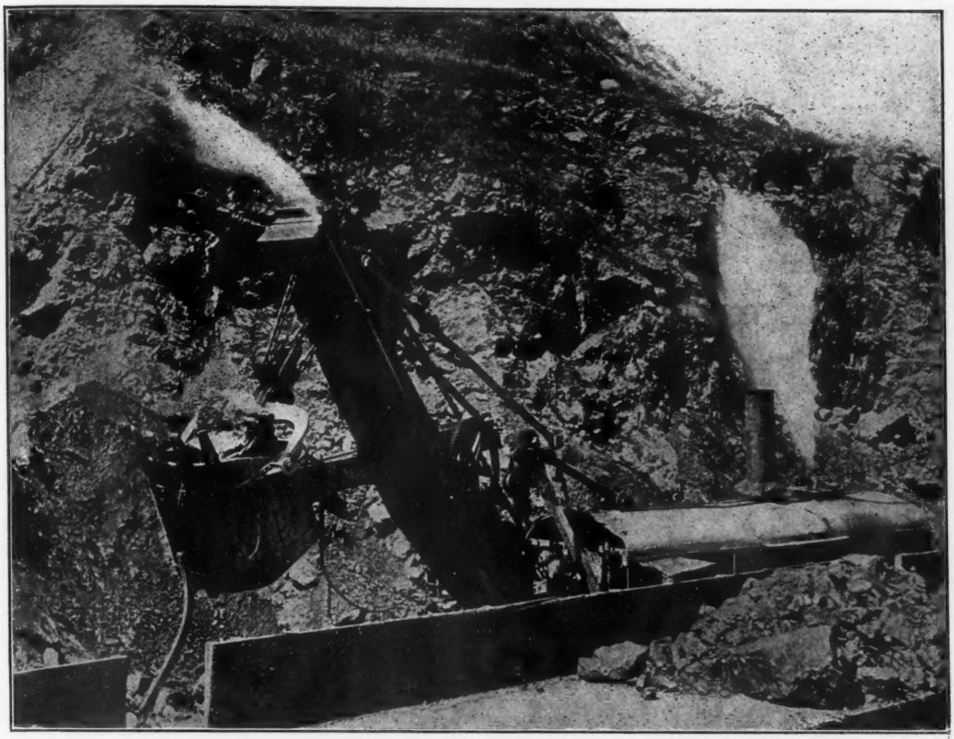
The speed of drilling, or the rate of penetration, is in direct proportion to the area of the hole being drilled, the smaller the hole the less the elapsed time in forming it. To accomplish the most economical result, it is therefore necessary, other conditions being favorable, to drill holes of the smallest practicable diameter and spring the holes previous to loading the main or blasting charge.

SPRINGING AFTER DRILLING.

The process of springing a hole consists in the detonation of a few sticks of high powered dynamite in the bottom of the drilled hole, this forms a chamber or pear-shaped cavity in the bottom of the hole in which to place the main blasting charge. Dynamite confined in this manner in the bottom of the hole, that is, the whole charge placed at that point, is, in its lifting and disruptive effect, more potent as there is not the large drill hole or well to permit the more rapid escape of the volume of gas generated on detonation of the confined explosive. To those not familiar with "springing" it is suggested that some time be allowed to elapse before introducing the main or blasting charge, as the heat generated in springing the hole will make the walls of the chamber hot enough to explode dynamite. Premature explosions due to this cause, and their attendant serious consequences, are not infrequent.

On the Central Division of the Panama Canal, the average number of vertical holes fired each day was 600, averaging 19 feet in depth. An average charge of 24 pounds of explosive was used to each hole. The average number of toe or horizontal holes blasted each day was 100, having an average depth of 15 feet; an average of 30 pounds of explosive was used to each hole. These holes are drilled horizontally into the toe of the bank to secure greater breaking effect of the material above.

Over 30,000 "dobe shots" or "mud caps" were fired in breaking up material ahead of the shovels; this material consisted of the fragments of too large a size for the shovels or cars. An average of about 6¾ pounds of explosive was used to each mud cap, at an average expense, for explosive and blasting, for each shot of 90 cents. One shot was fired to each 450 yards of blasted material excavated, which would make the general cost of



STEAM SHOVEL LOADING CARS. BAS OBISPO CUT.

mud capping throughout the section about one-fifth of a cent per cubic yard of all rock excavated. The average amount of material blasted, over the whole division, to each pound of explosive was 2.21 cubic yards. Saltpeter dynamites of sixty per cent. and of forty-five per cent. nitro-glycerine were used in blasting.

The foregoing recites the essential facts relative to excavation on the Central Division in the mixed materials, ranging from the hardest rock to the loosest and most crumbly formations that would justify the use of explosives in their further disintegration. In addition, there were certain clay formations, which were bored by hand-operated augers and blasted; it was found that the increase of cost entailed in boring and blasting was justified by the consequent increased output of the steam shovels. This was classified as "blasted material," the general term which comprises all materials mined and blasted on this division.

The unit cost of drilling and blasting, on the Central Division during the fiscal year 1912, was $0.1523. The complete operation, comprising drilling, blasting, excavation, transportation and dumping, and all overhead charges was $0.546 per cubic yard, on the dump. From the commencement of the work by the United States until September 1st, 1908, the complete division cost was $0.9344 per cubic yard; from September 1st, 1908, to June 30th, 1912, the cost of all material excavated, about 70,000,000 yards, three-quarters of which was rock, was $0.5127 per cubic yard.

COST OF HARD ROCK EXCAVATION.

The cost of drilling, blasting, excavating and transporting of a solid hard rock formation is illustrated in the excavation of a trap formation at Porto Bello. This rock is being used to form and armor the face of the breakwater at Colon. The excavation was developed in two benches of an extreme height of 60 feet. The rock was used in its rough form as blasted.

Loading from the excavation on cars is done by the steam shovels, then unloaded from the cars on to the decks of barges. The costs here given are on the deck of barge, it is considered that this would about correspond, in ordinary work, to the cost on dump or spoil

bank. Tripod mounted percussion drills of 3¼ inch piston diameter were used.

The average monthly cost of stripping, drilling, blasting, loading, transporting, upkeep of tracks, loading on barges, power, maintenance of equipment, and an arbitrary charge for plant, but no overhead or division expense, was $3.25 per cubic yard. These monthly costs varied from the first month at $5.98 per yard to a minimum of $2.16 per yard

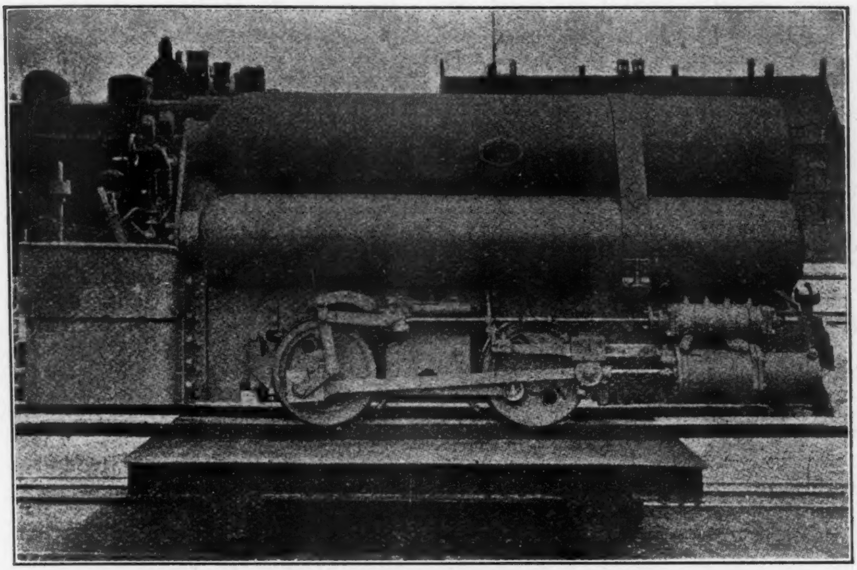
LIDGERWOOD UNLOADER.

These costs covered the excavation of 65,132 cubic yards in eleven months. In solid formations, admitting of close classification, the results obtained on the Isthmus would appear to about correspond to results obtained elsewhere under similar management.

The data from which the above report has been compiled are from the reports and statements of the engineers of the Isthmian Canal Commission, from the report of Mr. Donald F. MacDonald, geologist, and from the writer's own experience and from his personal observation of the work at Panama.

HIGH PRESSURE GAS LIGHTING

Discussions we have had with Europeans and Americans recently from abroad teem with expressions of delight at what is transpiring in foreign cities in the way of high pressure lighting. A citizen of this country, long a resident of England and recently on a visit here, told us that he was amazed at the widening development of high pressure lighting in Europe, especially in England, and particularly in London, and marveled that the country which gave birth to high pressure gas was so backward in its application to the lighting problem. "Why," said he, "in London high pressure lighting has thrown a pall over electricity. In some sections of London, owing to unexpired electric contracts, certain thoroughfares continue electric arcs on the one side and on the opposite side high pressure gas lamps have been installed; actually, the gas lamps throw shadows on the area immediately beneath the electrics—what's the matter with our gas friends over here?"



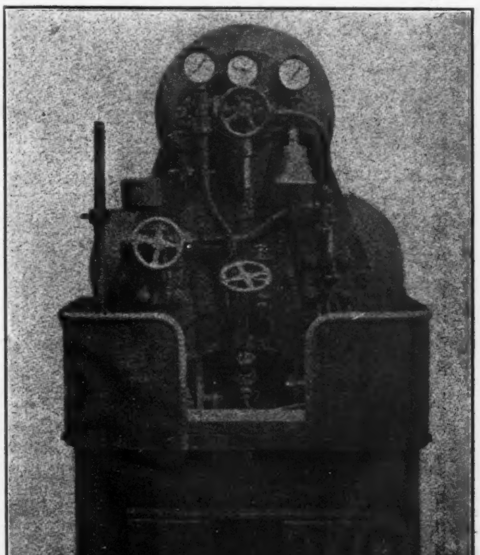
TRIPLE EXPANSION MINE LOCOMOTIVE.

COMPRESSED AIR TRACTION IN BRITISH COAL MINES

The following is a comparatively brief abstract of an interesting article by Axel Sablin in the Iron and Coal Trades Review.

According to this writer the adoption of compressed air traction in British coal mines is quite recent, but the improvements have followed each other with great rapidity, three periods of development being specifically noted. The first compressors, 1907, were designed for about 1500 lb. pressure. The locomotives had single stage cylinders, their tank pressures were about 750 lb. and the working pressure 150 lb. The reducing valve was one of the specially weak points of these machines. Not more than 4000 yards could be traversed with load without recharging and the cost per ton mile was too high to compete with electric traction.

By 1910, which is noted as the beginning of the second period, four-stage compressors worked up to 2250 lb. The pipes conveying the high pressure air were as small as possible, often 1¼ in., steel flasks were inserted in the line for storage and drainage. The locomotives had three or four tanks which would store the air at nearly full delivery pressure, and reliable reducing valves maintained a constant working pressure of 270 lb. The cylinders were compound with an atmospheric reheater between the high and the low pressure. The exhaust from the low pressure cylinders escaped through a nozzle arranged as



END OF LOCOMOTIVE.

an ejector similar to that of the steam locomotive. The remaining energy in the discharged air was thus used to cause a rapid circulation of air in the inter-heater, the low pressure cylinder was prevented from freezing and the admission pressure to the high pressure was thus correspondingly higher than in the older machines. Balanced valves and improved valve gear were adopted, the distance traveled between charges increased to 7000 yards and the air consumption of 1910 was 35 per cent. less than in 1908. Numerous plants were installed and pronounced economically satisfactory, thus encouraging further improvements.

In 1912 another remarkable advance took place. Compressors were built for five stage compression and the delivery pressure was raised to 3000 lb. The locomotives were built with triple expansion engines, using an initial pressure above 400 lb. The high pressure and intermediate cylinders formed a single casting, see Fig. 1. Separate interheaters were arranged between each two cylinders. The traveling distance between chargings, with load, was extended to 10,000 yards. The economy over the locomotive of 1911 was increased by 25 per cent. while the economy of 1908 was improved 55 per cent., so that the air consumption was only 45 per cent. of that of the first locomotives herein mentioned.

These modern locomotives weigh from 5 to 7½ tons; the gage used varies from 16 in. to 20 in., the minimum curve radius is 26 ft. and the maximum economical grade is 4 ft in 1000 ft. The overall length of the standard locomotive is 13 ft. 6 in., but shunting locomotives are built as short as 10 ft. 8 in. The smallest locomotive is 58 in. high and 36 in. wide; the largest 66 in. high and 40 in. wide. On good track, and with a run of not less than one mile, a locomotive has a proved easily maintained capacity of 250 ton-miles per shift of seven hours. The time of recharging the locomotive in the mine is about 1½ minute, a difference of about 300 lb. being left between the pipe line pressure and the pressure in the locomotive tanks.

The air, before being admitted to the compressor, should be filtered through cloth, the suction chamber having a very large filtering surface. The whole system of air pipes is packed with copper rings ⅛ in. thick, rolled from solid discs. Remarkably tight joints are secured by this method; in fact so perfect that in one instance under observation the drop in pressure in the system during the stop from Saturday to Monday amounted to only 150 lb., or about 6 per cent. of the working pressure.

For filling, the tanks of the locomotives are attached to the compressed air system by flexible drawn copper pipes, packed with the usual copper gaskets. Two filling stations are usually arranged: one at the bottom of the shaft, and another at the locomotive "stables." For lubricating, a special oil is used which remains liquid at —60 deg. C. (—76 F.) A train load usually consists of 40 cars, each carrying 1500 lb. of coal or over a ton of rock. On a good track, however, an air locomotive will haul twice this load.

During the last few years there have been put into service in German colleries many hundreds of air locomotives and close on to a hundred air compressor stations. Other plants are found in operation in Austria-Hungary, in Belgium, in France and in Spain.

The continental compressor works are well employed. In one particular shop were seen, in January of the present year, in various stages of construction, 38 air locomotives and 12 compressors, the largest being a five-stage machine with a capacity of 1,750 cu. ft. of free air per min. compressed to 3,750 lb. This compressor was to be driven by a gas engine.

STOPPING A BURNING HIGH PRESSURE GAS MAIN LEAK

The following was contributed by Mr. E. C. Jones, Chief Engineer P. G. & E. Co., San Francisco, in discussion of a paper read before the Pacific Coast Association:

Last September a telephone message came into the office of the Pacific Gas & Electric Co., San Francisco, between 1 and 2 o'clock in the morning stating that there was a high pressure leak in the suburbs of San Francisco. In 20 minutes after the word was received by Mr. Kepplemann he was on the job with a gang of men and found that three holes had been punctured into the 6-in. high pressure line carrying 75 lb. pressure. The gas had been ignited and the flames from the holes extended to a height of probably 25 ft., uniting at the top into one fan-shaped flame, illuminating the entire neighborhood, and the roar of the fire could be heard for blocks. The work was done by miscreants who made use of the sub-

stance known as thermit, which has been extensively used for the welding of cast iron and steel. The thermit was placed on top of the main in four places, close together, and ignited, burning holes through the steel pipe, and as the gas issued from the hole it ignited. One of the holes failed to work. Three of them ignited, causing an immense loss of gas, and it seemed when I got on the ground that it was really difficult to put out the fire.

The line which had been tampered with supplies the southern portion of San Francisco with high pressure gas and also all the towns on the peninsula, extending as far south as Palo Alto, and it was impossible at 2 o'clock in the morning to shut the pressure off the line, having on it thousands of consumers with water heaters and pilot lights, bath room lights and all manner of night lights, which it would have been a crime to have extinguished. The question arose, how should we extinguish this flame, because without putting it out it was impossible to stop the flow of gas and to make repairs.

Mr. Kepplemann suggested that in the natural gas fields he had seen means used for extinguishing natural gas leaks. He sent an automobile truck to the city yard and got a length of 6-in. steel tubing 20 feet long, and some rope; he placed the tubing on the ground at right angles to the holes, the holes being three-quarters of an inch in diameter. We reduced the pressure from 75 to 50 lb. on the line, knowing that this pressure would carry with perfect safety. Guy-ropes were fastened near the other end of the 6-in. pipe for the purpose of raising it to a perpendicular position. It was raised by these guy-ropes until it stood directly on top of the 6-in. pressure line and enclosed the leaks.

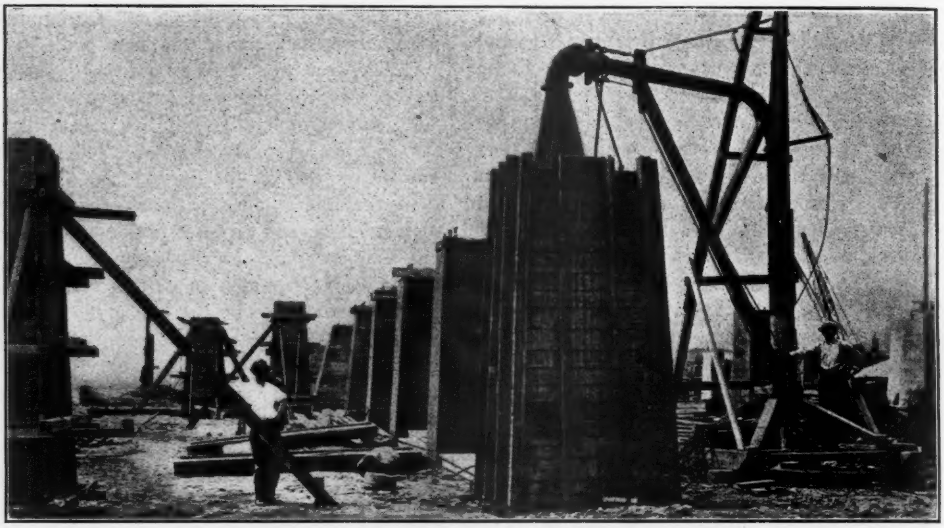
It only took an instant to stop the fire at that point because of the impossibility of the air getting to it. So after the 6-in. pipe dropped on the flame at its smallest point at the bottom, in a second the flame shot from the top of the stand-pipe and the moment it was seen that all of the flame was coming out of the top of the stand-pipe, word was given to let go of the guy-ropes and the pipe was thrown clear of the high pressure line, carrying with it the flame. The gas flame issued from the end of the 6-in. pipe on the ground for half a second or maybe a full second and burned the gas that was in it, but the flame from the high pressure line was extinguished.

We then had some soft pine plugs 4 ft. long prepared and driven into the holes and cut off, and the pipe was bandaged with 3-in. tape, something similar to tire tape, till the gas leak was entirely stopped. The pressure was then raised on the line and no consumers knew that there had been trouble of any kind. In fact, there was no interruption of the service. I mention the fact to show the necessity of having quick means of getting to a job; 20 minutes from the time the police reported this leak, our men were there with automobiles and it took but a few minutes more to go into town and get the length of pipe and the ropes and bring them out on the job. It could not have been accomplished with horses.

I want to call your attention to the necessity for the employment of resourceful men. A man of the calibre of Mr. Kepplemann can save his salary in a very few minutes. I have often been asked how to put out a gas fire on a high pressure main. I believe I have suggested a half a dozen methods and none of them worked, but this simple little thing turned the trick. If you ever have any trouble of that kind simply stand up a pipe and take the flame away. It doesn't matter what the diameter of the stand-pipe is. It may be 6 or 8 or 10 or 12 in. pipe—any pipe that you can handle freely. Be careful not to burn your men. Don't use a coated pipe. Any size pipe will trap the flame and take it away from the leak.

COMPRESSED AIR FOR BUILDING UP MASSES OF CONCRETE

At the Riverside plant of the Otis Steel Co., now under construction in Cleveland, a new method of mixing and placing concrete has been employed which is said to have effected a considerable saving. This method consists of mixing concrete by compressed air in a MacMichael pneumatic mixer and blowing it through an 8-inch pipe from the mixer to the forms. This system has been used in a number of other places. It was formerly used for tunnel lining exclusively, but for such work as the construction of the heavy footings and the high piers for the steel company's plant its economy also has been clearly demonstrated. The work on the Otis Steel Co.'s plant consists of some 40,000 cubic yards of concrete placed in heavy foundations

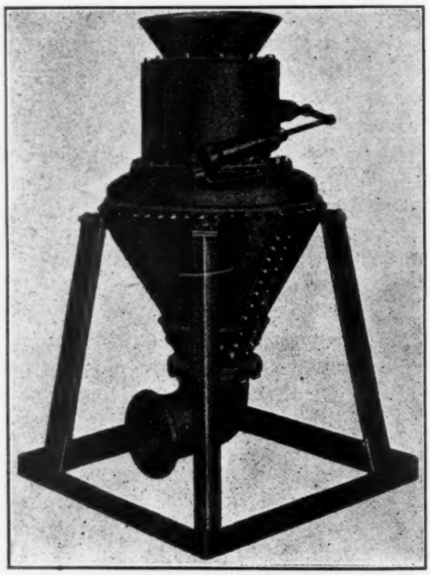


DELIVERING CONCRETE AT A PIER.

and high piers, as shown in Fig. 1. These piers contain from 10 to 19 cubic yards of concrete each. To fill them a goose-neck arrangement was made as shown in the illustrations. This was moved along on rollers between two rows of piers and was so arranged that it would swing to fill four piers each time the pipe line was extended. The pipe line extended 700 or 800 feet from the mixer at the farthest point. During the month of December, 1913, before the work was shut down for the winter, the machine mixed and placed 6,500 yards. This machine was of 1/4 yard capacity.

The mixer consists of a conical drum with an elbow at the bottom to which the conveyor pipe is attached, and with a hopper at the top which is closed by a door operated by an air piston. The cement, sand, stone and water are fed into the mixer through the hopper and the door is closed. The air is then turned on, entering the mixer at two points, one above the charge, and one at the heel of the elbow. The 80 pounds pressure which is used mixes the material and blows the mixed concrete through the bottom of the cone and through the pipe to the forms. The output of the machine is dependent upon the speed of loading. The mixers are made in 1/4 and 1/2-yard sizes and the speed of loading varies between 60 and 120 batches per hour. The provision of overhead bins makes possible a higher rate of loading, which would give the 1/4-yard machine a capacity of 30 yards per hour, and the 1/2-yard machine 60 yards. An 8-inch pipe of No. 10 gage metal or an 8-inch well casing is used for conveying the concrete. The facility with which the delivery pipe can be carried under, over or around obstructions which would make wheeling difficult, is one of the important advantages of the system.

The air required to operate the plant varies



THE MIXER.

according to the distance from the mixer to the forms, the number of elbows in the line, etc. A convenient method for estimating the required capacity of the air plant is to assume 1 cubic foot of free air compressed to 80-pound pressure for each lineal foot of pipe per batch of concrete. For general concreting work a compressor of 600 cubic feet per minute capacity is probably the best size, although a 300-cubic foot machine would be large enough to use with a ¼-yard mixer and 300 feet of pipe.

Clogging of the pipe may occur when stones of too large size are used. It has been found that the limit in size for successful operation is about 2 inches. Where crusher-run stone is used with this machine, as it has been on three jobs, a large rock occasionally gets in an elbow and plugs it. In some cases this can be loosened by tapping the pipe while the pressure is on, but if the rock is too large or too tightly wedged it is necessary to remove the pipe and punch out the obstruction. No clogging occurs, however, when the proper size of stone is used, providing the machine is not operated with an air pressure very much below 80 pounds. An air storage tank is usually placed close to the machine, the capacity of this tank being large enough to store sufficient air at 80 pounds pressure to discharge one load, which means 1 cubic foot of space for each 6 feet of pipe line.

SIZE OF PIERS.

The Otis Steel Co. used a ¼-yard machine at Cleveland for placing the piers for its new plant. The piers range in height from 12 to 18 feet above the ground, and each contains from 10 to 19 yards of concrete.

The machine is located under bins which are kept filled by clam shell buckets operated by locomotive cranes, the distribution pipe having a total length of 750 feet. The air is furnished by an Ingersoll-Rand motor driven compressor of 600 feet per minute capacity, and the plant is operated by eight men.—*Iron Trade Review.*

Vertical depths of shafts at the Calumet & Hecla copper mine, Michigan, are as follows:

	Feet.
Red Jacket	4900
No. 5 Tamarack	5308½
No. 3 Tamarack	5253

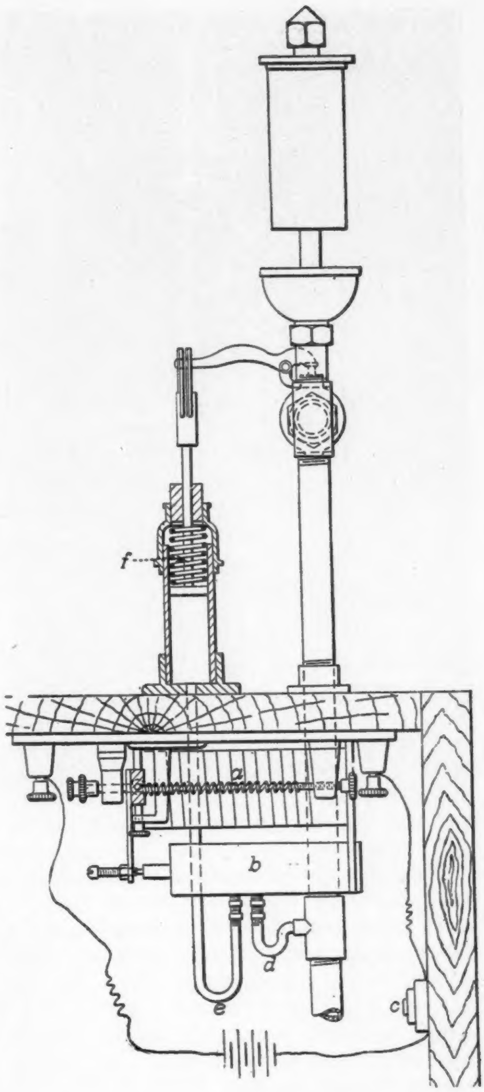


FIG. I.

A COMPRESSED AIR FACTORY CALL WHISTLE

For calling foremen, superintendents and others who frequently have occasion to leave their posts to go to different parts of a manufacturing establishment, the Newton Machine Tool Works, Inc., Philadelphia, Pa., has developed a compressed air call whistle controlled by an electric push button. Instead, however, of a 110 or 220 volt electric circuit, the whistle is operated from four dry batteries.

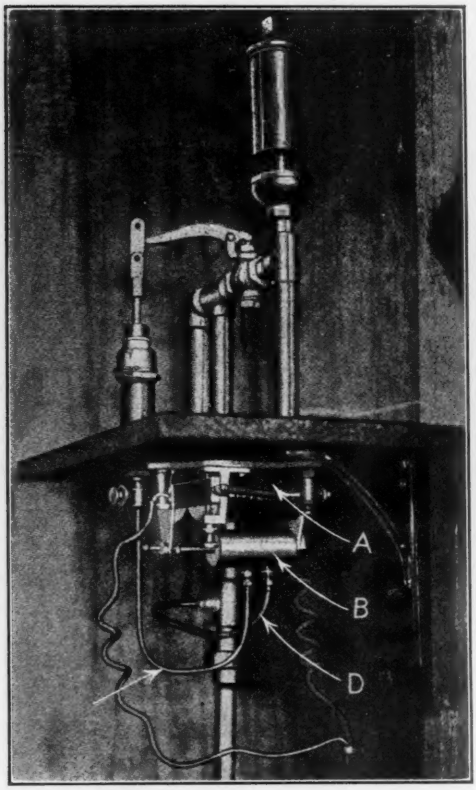
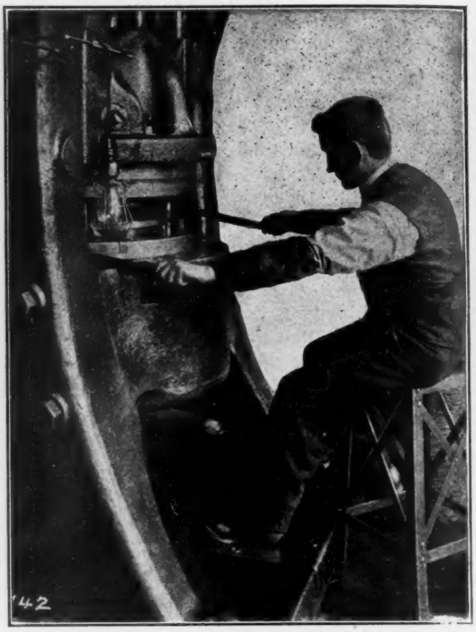


FIG. 2.

When this device, known as the Marx-Heisler call whistle, is installed in a factory, the push button may be mounted alongside of the telephone operator. The two principal parts of the device are a magnet, *A, a,* and the valve *B, b.* When the button *c* is pressed the circuit is closed through the battery and the magnet and the armature of the latter is attracted toward the pole piece. Attached to the armature is a downwardly projecting extension, which, when the magnet is energized is brought in contact with the projecting stem of the valve *B, b.* This stem is pushed in so that air flows into the valve through the pipe through the pipe *E, e,* the air compressing the *D, d* from the compressed air line and out spring *f* and permitting the whistle to operate. As soon as the pressure on the button is released the armature of the magnet flies back and the air which is flowing into the valve through the pipe *D, d* forces the stem back and cuts off the entrance to the pipe *E, e.* An exhaust port is provided for the valve to permit the spring to force out the air when the pressure is removed.—*Iron Age.*

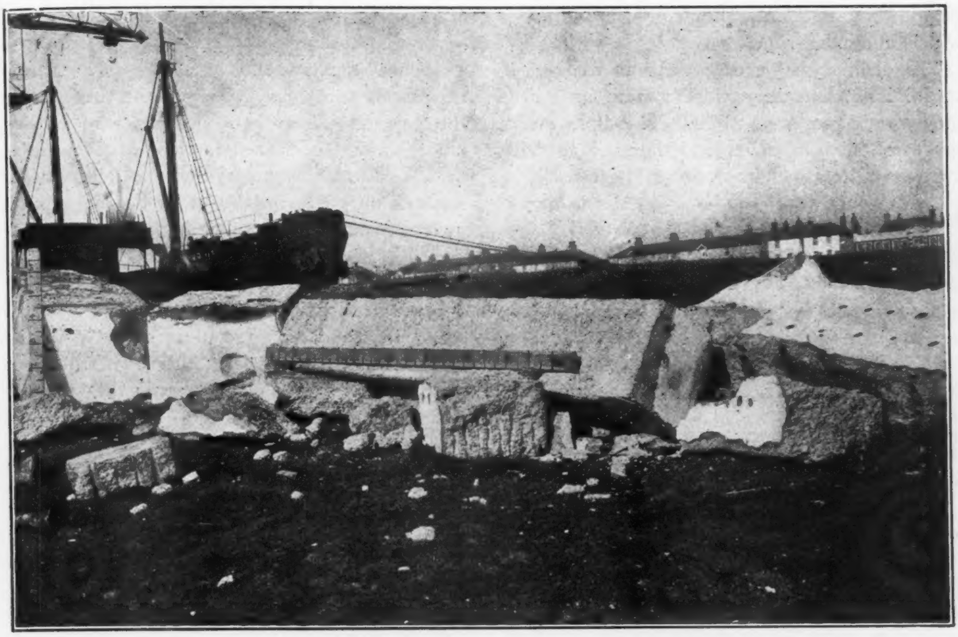


SAFETY VACUUM DEVICES FOR PUNCH PRESSES

For a considerable time the Westinghouse Electric and Manufacturing Company, at its shops at East Pittsburgh has been experimenting with mechanical devices for the safety of the operators in the punch shop, and after many discouragements practical success has been attained.

Before the adoption of the arrangement here illustrated a man was placed at the back of the press to feed in the sheets, and he was the man who most frequently was injured, because his fingers were entirely at the mercy of the operator in front. The vacuum lifting device enables the operator of a punch press in the first place to dispense with the helper, and at the same time all danger to the hands is removed.

It is an exceedingly simple affair, consisting of a "sucker" or lifter about 8 in. diameter which is connected by a rubber hose to a suction line running through the shop, and moves freely back and forth upon an irregularly shaped rod, its travel being controlled by the press operator by two guide arms or handles,



MONOLITHS CUT OUT BY JACKHAMERS.

one on each side of the punch and die and just inside the press housings.

A pile of metal sheets being placed in rear of the press preparatory to being punched, the operator in front pushes the guide arms through the press toward the pile. The irregularly shaped rod allows the sucker to drop until it rests upon the top sheet of the pile when a lever on one of the two guide arms is pressed, thus opening the vacuum valve and causing the sucker to grip the sheet. The guide arms and the suction lever are not released until the first blank has been punched. By thus retaining hold of the guide arms practically all danger of injury to the hands is removed, for in punching the succeeding blanks from the sheet it can almost invariably be pulled forward by means of the scrap or margin.

Since the adoption of the suction device there has not been an amputation on the large presses, and up to the present time no finger has been cut off in the punch shop.

The device was exhibited and received a grand prize at the recent International Exhibition of Safety and Sanitation, and it is now on exhibition in the American Museum of Safety, New York.

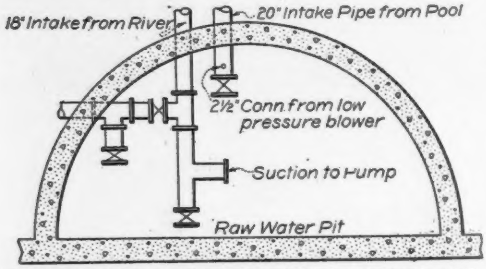
JACKHAMERS BREAK UP CONCRETE FOUNDATIONS

At the Brighton (Eng.) Corporation Electric Works there were some heavy concrete engine foundations to be removed and the half tone on this page tells the story. The concrete was exceptionally hard, made of clean, small beach, cement and gravel, and there was enough of the work to be done to make it worth while to arrange to do it economically and expeditiously. The engineer hired a 7 by 6 in. NE, Ingersoll-Rand compressor, and he was able also to borrow a couple of Jackhamer drills. The outcome of the job was so satisfactory that he finally bought the compressor and also another Jackhamer drill to be kept for another similar job in the near future.

The concrete was removed in large monoliths, some of them weighing 20 tons, split off from the mass by what is familiarly known in quarry work as the "plug and feather" method. A string of holes was drilled all around the monolith and the plugs were driven by a 2½ ton battering ram suspended from the big engine room crane. The block shown in the middle of the picture has been run out of the

engine house upon rollers, by means of a winch and wire rope.

The ordinary style of chisel bits were used, 20 in. long, and they were run in as far as they would go, say 18 in. The holes were spaced about 9 in. apart, and the average drilling was 7 holes an hour.



COMPRESSED AIR TO REMOVE ANCHOR ICE

At the Moline, Ill., Water works the water comes to the plant through two intake pipes, a 20-in. 350 ft. long and an 18-in. pipe 3,500 ft. long. The water flows by gravity to a well and is then pumped to the filter plant. The intake pipe with this air attachment extends something like 350 ft. into the river. It is open and unprotected at its mouth; no crib or other device has been built about the pipe.

Formerly a centrifugal pump was so arranged that it could be connected to the 18-in. line, and in an emergency the water could be drawn through this line until the well was filled, and then the valve on the choked 20-in. line was opened, letting the full pressure bear against the obstruction. The depth of the well is about 20 ft., and the head usually obtained by this means is but 15 ft. This system, while helpful at times, could not be relied upon, for as long as the 18-in. line remained open things were satisfactory, but just as soon as the ice began to choke, the plant was at a standstill.

During the past year the chief engineer, Mr. Buck, has attempted to improve the plan by connecting the blower used to air wash the filters to the 20-in. line. The blower used is of the Root make, giving a large volume of air under low pressure; that is, up to about 10 lbs. At times for very short periods the pressure has been forced up to 30 lbs. The connection between the blower and the line is through a 2½-in. pipe connected to the intake pipe, near the raw water well end.

On nights when the temperature conditions indicate a slight freezing, the height of the water in the raw water well is carefully watched. When the level begins to drop, the blower is started and in a very short time the line is completely cleared. At times when the line has been choked tight, the blower has without fail cleared the line in a few minutes. The maximum pressure needed or used for this purpose runs about 10 lbs. per square inch. From the accompanying diagram the layout of the raw water well and the air connection can be clearly understood.

The Mississippi River water, turbid and colored, seems to be affected in no way in the formation of anchor ice, other than the temperature. It is claimed by some that the appearance of this ice occurs only on certain nights—nights following clear days, or a clear night, not cloudy ones, etc. Clear days and cloudy days alike seem to have little influence over the ice problem in the Mississippi River so far as we have been able to observe. The main trouble usually becomes noticeable after midnight and remains until the appearance of daybreak.

The above information is taken from a paper by Mr. L. A. Fritze, chemist of the Moline water department, before the Illinois Water Supply Association.

STRUGGLE BETWEEN LIGHT AND HEAVY WATER

A difference in water density at the lower ends of the Miraflores and Gatun locks at Panama has, according to the "Canal Record," developed a current of probably 3 or 4 miles per hour under certain conditions. At the stage of a downward lockage when the surface of water in the lower chamber has been brought down to evenness with that in the approach the water within the chamber is more than half fresh. It has, in consequence, less density than the sea water beyond the lower gates, and when the gates are opened the heavier water thrusts its way inward against the lighter, causing a current opposed to the outward passage of a vessel. The current being temporary, causes no serious inconvenience, and is being studied principally to determine accurately the conditions for the manipulation of the towing locomotives.

A tunnel under the Danube is planned by the Roumanian Government to form a connection with its newly acquired territory.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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Vol. XIX. JUNE, 1914. No. 6

CONTENTS

ALFRED NOBLE

At three score years and ten a useful life
Has run its course. And as we think of him
The sorrow and the flowing tears of friends
Are turned to joy that such a one as he
Has lived and wrought. He was a man who led
In building up, his mind endowed to see
And think and do in all the larger things,
A Captain leading men on Nature's fields
To win in building monuments of peace.
This Engineer has shattered Nature's works
To make the world a better dwelling place
For all of us. His life was gentle and
No thought of self within him dwelt. He won,
Scarce knowing why, the plaudits of the world.
Above his resting place let it be writ:
He was an Engineer. He was a Man.

W. L. S.

COMPRESSED AIR TRACTION IN COAL MINES

On preceding pages of our present issue we have an interesting, authoritative account of the recent developments in and the present status of compressed air locomotive traction in British, or, more correctly, in Continental coal mines. Perhaps the most astonishing thing about it is the rapidity with which the improved practice has developed and the large increase of economy attained. Within seven years, we are told, the power cost of compressed air mine traction has been reduced more than one-half, while the service has been improved in various other ways, so that it is no wonder that the builders of the special locomotives required and of the compressors required for charging them have their hands full. The leading and most successful practice, it appears, is not in British mines, but in Continental Europe, where from our mistaken and too fixed habits of thought we would have least expected it.

Those who are now reporting these successes may be said to have begun where we left off, when there should have been no such "leaving off," no acceptance of things as they were. The mistake in British, and perhaps more pronouncedly in American practice has been in not following up the opportunities for improvement which would have been easily discoverable if properly looked for. In too many coal mines where compressed air traction is now accepted as more or less of a ne-

cessity single stage locomotives are still in use. Conpound locomotives are now in many cases replacing them, and these are giving good account of themselves, but the day of the triple expansion locomotive seems not yet to have arrived.

SUCCESS OF HIGH PRESSURE ILLUMINATING GAS

The following we take from a valuable paper by Mr. F. Victor Westermaier, of Philadelphia, before the Illinois Gas Association at Chicago, March 18.

Without reference to the highest type of lighting made possible with gas raised to two and three pounds pressure per square inch, the subject of gas street lighting would be incomplete. The advantages of high pressure gas lighting have been so evident where high candle power units and greater efficiency are required, that numerous cities abroad have adopted it as the principal illuminant for street lighting. With units of 1,000 to 4,500 candle power, operating at efficiencies of 45 to 60 candles per cu. ft. of gas consumed, not only is the standard of street lighting raised, but is given a formidable position as the highest powered illuminant. Notwithstanding the large investment required for special mains, compressor plants, new lamps and posts, Berlin, London and Paris are continually extending high pressure gas street lighting. These extensions are being made solely on merit and in sharp competition with the most modern electric units.

In Berlin one finds the greatest systematic municipal developments along modern lines, therefore its adoption of high pressure gas street lighting, to the extent of sixty miles of principal streets, should serve as a stimulus to the entire gas lighting industry. While it owns the principal gas plants within its limits, it also has in a way control of the electric light plants, in that the city will acquire them in tht near future. There is no indication that the fact of ownership gave gas street lighting in Berlin any advantage over electric lighting. Not until extensive, careful, experiments had been carried out in the most systematic manner, was gas finally adopted, it having demonstrated conclusively its absolute reliability and fitness for delivering the high degree of illumination required, at a lower cost than could have been obtained with electricity. The influence of Berlin's adoption of high pressure gas lighting has spread to many European capitals.

In view of the development of high pressure distribution systems in America, it is remarkable that the advantages of high pressure lighting have not been recognized and advanced. The installations made so far have been mostly of an ornamental nature, for lighting the exteriors of gas office buildings. There are, however, two street lighting installations which have been in operation for a sufficient length of time to demonstrate the practical advantages of introducing large candle power units where high pressure gas is available. One of these is at Atlantic Highlands, N. J., where fourteen 500-candle power units, were installed early in 1913. After a year's operation the service rendered has been so satisfactory that the number of lamps has been doubled with the prospect in view of a further extension of high pressure lighting throughout that entire district.

The other street lighting installation is at Waterbury, Conn., for lighting the approaches to the Railway Station. The fact of there being a high pressure feeder line nearby, enabled the gas company to install seven 500-candle power lamps. These units have given very satisfactory service for over three years, and had it been practical to extend high pressure mains in other parts of the city, additional gas street lighting could have been obtained. The polar curve of the lamps at Waterbury and Atlantic Highlands shows that for street lighting purposes the distribution of light in the vertical plane from an inverted mantle is much better with high pressure than with low pressure gas.

Probably the finest example of street lighting in the United States was shown in Philadelphia during the convention of the National Commercial Gas Association in December, 1913. Thirty-six lamps were mounted on both sides of Broad street, between Walnut and Spruce streets, high pressure gas being supplied through a line of 3-in. main temporarily laid on each side of the street and connected with a booster plant in the convention hall. Each lamp was equipped with a mercury seal distance lighter, located in the base of the post, which opened the gas valves to the burners when the pressure in the main was raised to the required three pounds per square inch; closing them, and opening the pilot supply when the pressure was reduced to normal.

SAFETY FIRST IN SHAFT SINKING AND TUNNEL CONSTRUCTION

BY WALTER I. SWEET.*

A great deal has been said about the Catskill Aqueduct as an unparalleled achievement in engineering, but very little has been said or written about the appalling cost in human life, and the maimed bodies of those who have been engaged in making this aqueduct a reality. There have been in the neighborhood of 300 lives lost, and more than 6,000 persons have been seriously injured The builders maintain that the toll is one that must be expected in an engineering task of such a magnitude.

In the opinion of one who has made a minute study of the causes of most of the casualties, more than 50 per cent. of the accidents could have been avoided if the proper precautions had been taken. One day a man is killed by a premature explosion, and the next another is crushed to death by a falling rock from the roof of the tunnel, or from the walls of a shaft, and so it goes on.

SHAFT SINKING AND TUNNEL CONSTRUCTION.

Shaft sinking and tunnel construction were two of the most hazardous occupations that were engaged in while constructing the Catskill Aqueduct. It has not always been the builders who have been to blame for the numerous casualties that have occurred. A great many of the accidents have been directly due to the carelessness of the miners themselves. Another cause for a great many of the accidents can be put up to the superintendents in charge of the different shafts and tunnels, as there is considerable rivalry shown between these men, one trying to drive a few feet more of tunnel or shaft than the superintendent in the adjoining shaft or tunnel. It is necessary to keep hounding the drillers and muckers, and the continual speeding up methods caused the men in charge of the work to set aside due caution. This generally resulted in serious accidents. While a very few of the builders go into the tunnels, they always instruct their superintendents to prevent accidents at any cost. Accidents in this class of work can be reduced when men engaged in directing the operations become educated to the fact that one accident will cause more delay than a few hours spent in installing proper safeguards.

It has always been a hard problem for the builders of shafts to install any means for guarding the muckers and drillers engaged on this class of work. It is only practicable to concrete a shaft 50 feet from the bottom, for if the timber or concrete was extended to a greater depth it would be injured by the blasting operations. The muckers and drillers are constantly exposed to falling material, buckets and rock both from the walls of the shaft and from the surface. It is necessary to use the utmost precaution when operating buckets over the heads of the workmen in the shaft.

Safety hooks should always be provided and the cables and engines should be periodically inspected by competent men. A number of accidents on this class of work have been due to the carelessness of the engineer in charge of the hoisting engine. The engineer lost control of the engine, which resulted in the dropping of the bucket containing a number of men onto the drillers in the bottom of the shaft. These mishaps caused the death of a number of men. Casualties of this kind can only be avoided by installing engines with an automatic brake. The type of brakes now in use necessitates the engineer holding his foot on a treadle, and if anything occurs to the engineer the engine is bound to race.

In sinking the river tunnel of the Catskill Aqueduct it was necessary to devise some means to protect the men in the shafts from shooting rocks. A form of steel support was therefore designed by the engineer on the ground to meet this condition. It consisted of 8-in. 13¾-lb. channel ribs, or rings, spaced 4 feet 6 inches on centers, and lagged with ⅜-inch plates, 25x48 inches, curved to the radius of the rings. The plates were bolted to the outside of the channels which were bent web out. The ribs were formed by four quadrants bolted with the curbed fish plates. They were placed by hanging them from the next higher ring by means of long bolts with pipe separators. Every third to sixth ring was further supported by resting it on steel dowels driven into holes drilled in the rock walls of the shaft. It was practicable to keep this steel support within 15 feet of the

*Safety Inspector for the General Accident, Fire and Life Assurance Corporation. Abstract from *Safety Engineering*.

shaft bottom. With this extra precaution the accidents which were caused by shooting rocks were decreased considerably. One of the contractors engaged on this work devised a heavy wire screen guard which was supported by angle iron. This guard was suspended over the muckers and drillers to prevent them from being injured by any falling rock or material. This screen guard was abolished after a short duration of service. Owing to the irregular shape of the shafts it was necessary to make considerable changes in the shape of the screen as the work progressed. One precaution that can be taken is careful and frequent scaling of the walls of the shaft. It is necessary to stop the work of drilling and mucking while the scaling is being done, and on this account the work is very seldom done thoroughly. Scaling is work that is very tedious and it is also very hazardous, and unless this work is looked after by competent men there are bound to be a great many accidents due to falling rocks. After the shafts have been sunk to the required depth, the frames and guides for the cages are installed, and after this work is completed the hasardous work in connection with shaft sinking ceases.

Gates are provided for guarding the cages. They are not automatic, but are raised and lowered by a signal man whose duty it is to work these gates and signal the engineer when to start or stop the cage. There is a steel roof on the cage to protect men riding on the lift from being injured by falling material or rock. Each cage is equipped with safeties which hold the cage firmly to the guides in case the hoisting cables break or become slack. The hoisting engines are equipped with overwinding devices which automatically stop the cage at the limit of travel, both at the top and bottom of the shaft.

The safeties on the cages are inspected periodically by cutting the cables and allowing the cage to drop, this being the only proper means for testing this type of safety. Accidents due to the falling of a cage have been very rare. No gates are installed at the bottom of the shaft as they would be more liable to cause an accident than to prevent one. A few fatal accidents have been caused by employes being killed due to the operation of the cages. One of these accidents was caused by an employe reaching into the pit to get water just as a cage was descending, and the man was killed by the cage. No matter what sort of a guard had been installed it would not have prevented an accident of this kind. A great number of the accidents that occur in shaft sinking can be avoided if a few safeguards are installed, and if the men engaged in this class of work will use precautions.

TUNNEL CONSTRUCTION.

Tunnel work cannot be compared with shaft sinking from a hazardous standpoint, as the miners are not subjected to the constant hoisting of material and buckets over their heads. Accidents in tunnel work can be prevented by installing the proper safeguards, and educating the men themselves not to take chances and how to avoid accidents. A few safeguards that are practicable to use on this class of work will be seen in pictures in different parts of this article.

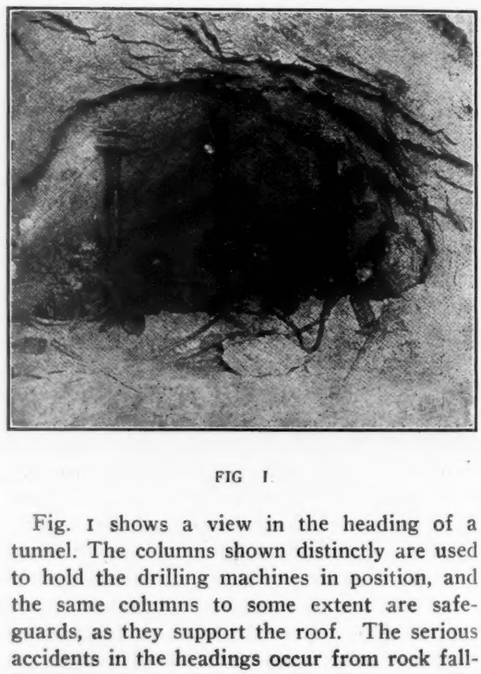


FIG I

Fig. 1 shows a view in the heading of a tunnel. The columns shown distinctly are used to hold the drilling machines in position, and the same columns to some extent are safeguards, as they support the roof. The serious accidents in the headings occur from rock falling from the roof and walls of the tunnels. These accidents may be prevented by proper scaling. Premature explosions have caused an appalling toll of death. There have also been a number of accidents which have been caused by the muckers' picks and shovels striking an unexploded stick of dynamite, but the two last named causes for accidents are gradu-

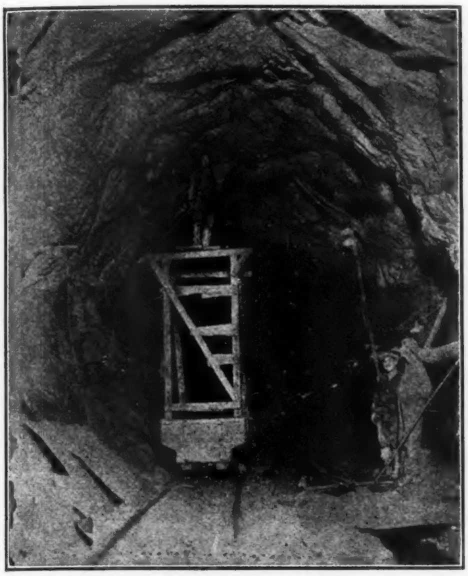


FIG. 2.

ally being obliterated. Fig. 2 will show how effective scaling can be done.

While making an inspection of a certain tunnel the writer had occasion to witness a fall of rock from the roof that was 65 ft. long, and about 6 ft. in diameter. This fall caused the death of one man. It was miraculous that no other casualty occurred, for if this fall had occurred during the changing of a shift the loss of life would have been appalling. The proper scaling of the roof of this tunnel would have detected this loose rock and the accident would have been avoided.

The mucking is done by a very poor class of men, and, as the work is not very desirable, there is a constant changing of the men, so that a gang of unskilled laborers is on this work all the time. This condition also is the cause of the numerous accidents that occur on this work, for as soon as the men get so that they can wheel the barrow over the planks without falling they give the job up for some more desirable work. The platforms used for mucking need constant inspecting, for the men who set them up do not secure them properly. Insufficient light is another cause of a great many of the accidents, as in most cases very poor light is provided on the benches and in the headings.

The concreting of a tunnel is also a hazardous class of work. The moving of the heavy forms in congested quarters caused a great many crushed hands and feet, but most of these accidents are unavoidable. A more skilled class of men are employed in concreting and the only safeguard is for the men to use precaution.

The electric locomotives which are used for conveying material in the tunnels have been the cause of a great many accidents that could have been avoided. A poor class of men is employed to operate these locomotives, this condition being the direct cause for most of the accidents that have been due to the operations of the trains. The employes have orders not to ride on the trains, but this order is not obeyed. Some of the most serious accidents that have been caused by the trains are—no means of signaling, no taillights on the trains, poorly constructed track, low timbers from the forms, and from running the trains too fast.

The electric hazard in the tunnel has also been the cause of a great many serious accidents. The tunnels for the greater part are extremely wet and 500 volts are carried on the wires used to drive the locomotives. This wire is low and within easy reach of the men riding on the trains, and the employes engaged in placing the concrete forms work continually about this wire.

While considering "Safety First" in the tunnels and shafts, the safeguarding of the equipment on the surface and in the tunnel should not be overlooked. While it may not always be practicable to safequard tunnelmen and shaft sinkers, it is practicable to safeguard all the machinery used in connection with this work. Some of the machinery that has caused a number of avoidable accidents are concrete mixers, crushers, screeners, conveyors, hoisting engines, derricks, tramways, steam shovels and power plants.

A great deal more can be said in connection with installing safeguards on work of this nature, but the writer has only attempted to set forth the most hazardous parts of the work, and to mention a few practical means of safeguarding the workmen. Every means towards preventing accidents that has been mentioned in this article is practical and is in use along the whole distance covered by the Catskill Aqueduct. The use of such guards will reduce accidents 80 per cent. The guards mentioned in this article can be used on all

classes of contracting work. To get good results towards preventing accidents on all engineering work, the work should be inspected by competent inspectors. While contractors and engineers engaged in construction work wish to reduce accidents to a minimum, they have not the time to spare to give this branch of the work proper attention.

I wish to acknowledge the courtesy of my chief engineer, Mr. C. S. Whitney, for permission to use the pictures and data from the files of the corporation.

NEW BOOK

Compressed Air. A treatise on the production, transmission and use of compressed air. By Theodore Symons. New York, McGraw-Hill Book Company. XII+173 pages 6x9 in. 42 cuts, appendix of tables. Price $1.50.

This book serves up the familiar data relating to the compression and transmission of air with somewhat more than the usual mathematical trimming, and it should appeal to the faculties of freshwater colleges as an ideal text book. We cannot recommend it to the practical man, because it is so far from covering the now extensive field of compressed air practice, and such a man after going through it would want to know just what he wanted to know before. Typograpically the book is one to be proud of.

NOTES

J. Spencer Smith, William L. Saunders and Richard C. Jenkinson, who constituted the old New Jersey Harbor Commission created in 1911, have been named as three of the five members of the newly created permanent commission. Their terms of office will be respectively five, four and three years from April 1. The other two nominees, whose terms will be respectively two years and one year, are W. Parker Runyon and Charles S. Boyer.

"The Ingersoll-Rand Company announces the opening of a new branch office and warehouse in the city of Los Angeles, California, 1036 Union Oil Bldg. This branch will be in charge of Mr. W. A. Townsend, formerly Manager of the Company's El Paso office. Mr. J. D. Foster succeeds Mr. Townsend as Manager of the El Paso office. Also the opening of a branch in the city of Juneau, Alaska, under the immediate charge of Mr. Frank Carroll. Mr. Walter A. Johnson, formerly of Atlanta, Ga., has been appointed Pneumatic Tool Manager of the Pittsburgh Branch of the Ingersoll-Rand Co. and Mr. C. F. Overly, formerly of Pittsburgh, Pneumatic Tool Manager of the Company's Cleveland Branch."

One of the Panama Canal locks at Gatum has been used as a drydock for overhauling five submarines. As the locks are in pairs this can be done without interfering with the passage of vessels through the other side.

A new system of signaling has been instituted at the Windsor colliery, in South Wales. They are endeavoring to abolish all electric signaling, and have devised a scheme of signaling with blast hooters, which have been put on every main-haulage engine on the east side of the colliery. The hooters are attached to a compressed-air column, and this is said to operate successfully. The pulling of a wire which runs along the roadway gives the signal to the engineman.

Under the old method of ventilating the tunnels of the London Underground Railways the air was withdrawn by means of an exhaust fan. By the device now being installed at the Edgware-road, Euston, and at the new Embankment Station, unlimited supplies of air will be pumped into the tunnels throughout the day and night. Ordinary air is passed through a washing screen which extracts all impurities, the requisite humidity is next imparted, a proportion of ozone is added, and it is then sent into the stations at the rate of 25,000 cubic feet per minute.

In the recently enacted law of the State of New Jersey for the regulation of work in compressed air it is required that employers carrying on compressed air work shall employ one or more licensed physicians; if the maximum air pressure exceeds 17 lbs. they also must employ one or more registered nurses to act in case of accident or illness from the compressed air. The bill provides that every tunnel, caisson, compartment or other place where compressed air is used and to which the act applies shall be so construct-

ed, equipped and operated as to provide proper protection to the persons employed. One provision is that no person known to be addicted to the excessive use of intoxicants shall be permitted to work in compressed air.

An extraordinary fatal accident occurred at the Morning mine in the Coeur d' Alenes, as noted by state mine inspector, Robert N. Bell, in his report for 1913. One J. R. Jones was hammering an ore chute that was hung up two floors above. It is customary to cut vent holes in these chutes at every floor but the vents at this point had got choked with muck. When the heavy mass of wet ore let go, therefore, it acted as a great piston, compressing the air below it in the chute and blowing off a plank. The plank struck the man hammering the chute and crushed his head against the ladder, killing him.

A rope railway, 75 miles in length, is to be put into operation in India. It will connect the rich country in the vale of Kashmir with the plains of the Punjab over the Himalayas. The line, it is claimed, will be the longest in the world, the present longest being 22 miles and situated in Argentina. Sections will be 5 miles long, and most of the spans will be 2400 ft. The steel towers, some of which will be 100 ft. high, will be braced, and double 1½ in. cables, 9 ft. apart, will carry the steel cars. The carrying capacity of these cars will be about 400 lb.

A means of obtaining extra high temperatures from an electric arc is described in the *Electrician*. The method consists of combining with an ordinary electric arc a jet of air or oxygen or an oxy-acetylene or oxy-hydrogen flame. The simplest form of the apparatus has a hollow carbon electrode through which a blast of oxygen or air can be blown. The metal plate to be heated forms the positive pole and the carbon electrode the negative. The arc is struck in the ordinary way and operated by a special mechanism with a hand feed. Several other arrangements may be used, some of which have separate pipes serving to project the oxy-acetylene or oxy-hydrogen flame on to the electric arc. It is stated that the effect of the oxygen burning inside the arc is to produce a temperature greatly in excess of that of the electric arc alone; also a similar effect is obtained when the oxy-acetylene or oxy-hydrogen flame burns in the same space as the electric arc.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 7.

1,092,141. ELECTROPNEUMATIC BRAKE APPARATUS. EDWARD H. DEWSON, New York, and WALTER V. TURNER, Edgewood, Pa.

1,092,237. PNEUMATIC ROCK-DRILL. THOMAS J. BARBRE, Denver, Colo.

1,092,268. LOCOMOTIVE SAND-BOX. HARRY IDOINE, Altoona, Pa.

1,092,278. COMPRESSOR. EDWIN M. MACKIE, North Tarrytown, N. Y.

1. In combination with an air compressor, fluid pressure actuated mechanism, a valve controlled thereby and co-operating with the compressor and arranged when operated to cause the compressor to work without compression, valve mechanism for admitting and releasing compressed air to and from said fluid pressure actuated mechanism, and comprising independent admission and release valves, and a governor proper controlled by the speed of the compressor and having two plungers movable in unison in accordance with the speed of the compressor and arranged to operate said valves respectively.

1,092,302. PULVERIZING OR GRINDING MACHINE. EDWARD J. STECKLE, El Paso, Tex.

1. The combination with a pulverizing mill having means for exhausting air together with fine material from the pulverizing chamber above the pulverizing elements and for returning the air freed from the fine material to the pulverizing chamber of the mill above the pulverizing elements, of means below the pulverizing elements for the escape by gravity of pulverized material from the mill, and means for directing the fine material extracted from the air exhausted from the mill to the material escaping by gravity from the mill.

1,092,339. DEVICE FOR ACCELERATING THE APPLICATION OF PNEUMATIC BRAKES. FRANCOIS JULES CHAPSAL and ALFRED LOUIS EMILE SAILLOT, Paris, France.

1,092,396. AIR AND GAS COMPRESSOR. MICHAEL RIESNER, Cincinnati, Oho.

1,092,495. AIR-PUMP. CARL E. L. LIPMAN, Beloit, Wis.

1,092,641. AIR-TANK. WARD V. GARCEAU, Grand Rapids, Mich.

1,092,680. TRACK-SANDER. JOHN H. WATTERS, Augusta, Ga.

1,092,718. TRAIN-STOPPING APPARATUS. ARNOLD O. JOHNSON, Elnora, Ind.

1,092,782. GAS-COMPRESSOR VALVE MECHANISM. CASPER W. MILES, Anderson township, Hamilton county, Ohio.

1,092,804. PNEUMATIC DUST - REMOVER FOR CARDING-ENGINES. JOSEPH J. SMITH, New York, N. Y.

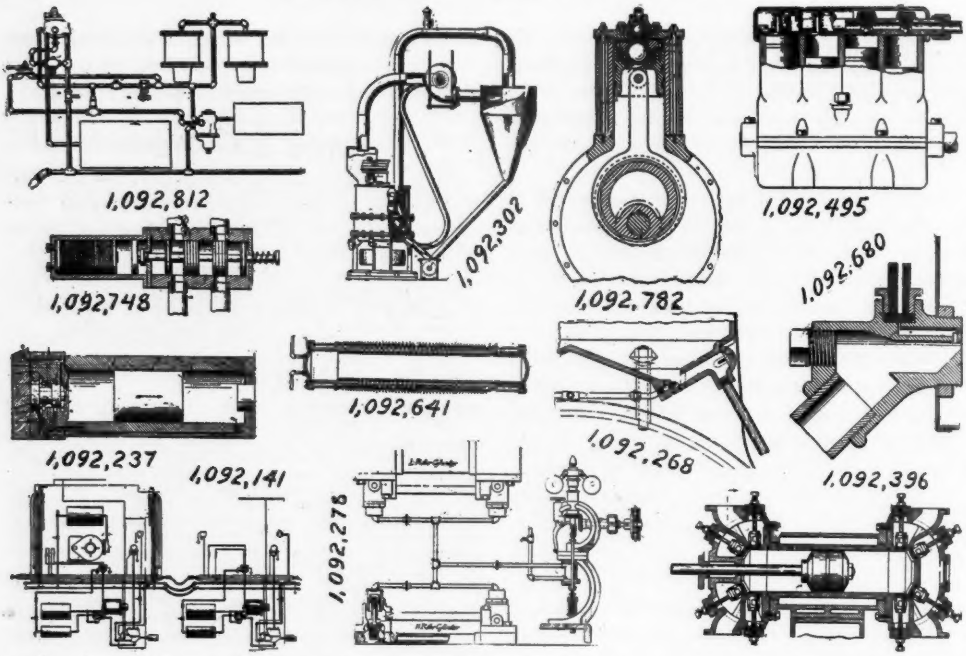
1,092,812. AIR-BRAKE SYSTEM. FRANK H. DUKESMITH, Meadville, Pa.

APRIL 14.

1,092,852. FURNACE AND AIR-INJECTING NOZZLE THEREFOR. JOHN H. PARSONS, Philadelphia, Pa.

1,092,873. IMPULSE-PUMP. WILLIAM H. STUTZ, Toledo, Ohio.

1. The combination of a cylinder, a floating pump piston movable in the cylinder, means for permitting air to pass in but one direction to the compression side of the pumping piston, means for pneumatically operating the piston, and an engaging means for holding the said piston at one end of its stroke until the pressure

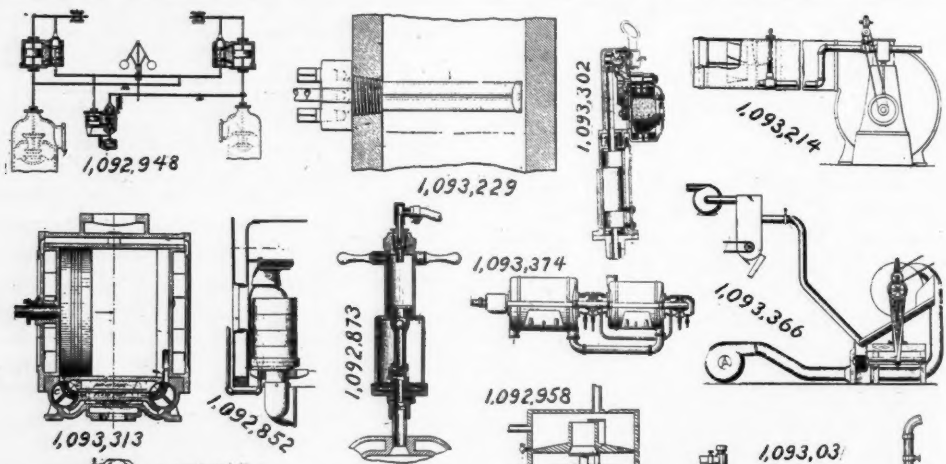


PNEUMATIC PATENTS, APRIL 7.

produced by the said pneumatically operating means is sufficient to release the piston which is driven by the said pressure.

1,092,886. ROCK-DRILL. CHARLES ERNEST YOUMANS, Yonkers, N. Y.

1. In a rock drill, the combination with two cylinders of different diameters arranged axially in line, of pistons in said cylinders, a piston rod common to both pistons and adapted to receive a tool at its end, the smaller cylinder and



PNEUMATIC PATENTS, APRIL 14.

piston being at the tool end, the combustion end of the smaller cylinder being nearest the tool, and the combustion end of the larger cylinder being removed from the tool, and means for admitting combustible charges to said cylinders and for igniting said charges to cause the charge in the larger cylinder to drive the tool forward and to cause the charge in the smaller cylinder to retract the tool.

1,092,943. AMMONIA-COMPRESSOR. PETER NEFF, DONALD COLE, and ELBERT L. EBERSOLE, Canton, Ohio.

1,092,947. ELASTIC-FLUID TURBINE. WILHELM PAPE, Charlottenburg, Germany.

1,092,948. REGULATOR FOR MIXED-PRESSURE TURBINES. WILHELM PAPE, Charlottenburg, Germany.

1,092,949. AIR-BRAKE APPARATUS. WILLIAM E. PARKER, Manning, Tex.

1,092,958. AUTOMATIC RAILWAY-BRAKE VALVE. BENJAMIN F. SHURZ, Marion, Ohio.

1,092,982. PNEUMATIC TRANSMISSION SYSTEM. FERNAND E. D'HUMY, Englewood, N. J.

1,093,031. METHOD OF RAISING FLUIDS FROM ARTESIAN WELLS. FRANK O. BROWN, Dallas, Tex.

3. A method of raising fluids from a subterranean fluid-bearing strata, consisting in forcing compressed air into one of two wells extending into the strata and communicating at their lower ends, thereby forcing out through the other well the fluid normally standing in both wells and in the passage connecting the same, subsequently connecting either well with a receiver, equalizing air pressure in the receiver and wells, and finally pumping air from the wells into said receiver, until the air pressure in the wells becomes substantially atmospheric.

1,093,048. PERCUSSIVE TOOL. CHARLES H. HAESELER, Philadelphia, Pa.

1,093,114. FOUNTAIN-BRUSH. JAMES G. CORBETT, Beaver Falls, Pa.

1,093,116. GOVERNING MECHANISM FOR TURBINES. LUDWIG CUBELIC, Charlottenburg, Germany.

1,093,214. FAN OR BLOWER SYSTEM. NORMAN L. SNOW, Plainfield, N. J.

1,093,229. PITOT PLUG FOR FLUID-METERS. JAMES WILKINSON, Boston, Mass.

1,093,299. UNLOADING DEVICE FOR COMPRESSORS. WILLIAM F. TREIBER, Corning, N. Y.

1,093,302. PRESSURE-DEVELOPING PNEUMATIC TOOL. JOHN L. WAGNER, Syracuse, N. Y.

1,093,313. DRY VACUUM-PUMP. EVI WILLSON CHRISTIE, Sewaren, N. J.

1,093,366. MATCH-SPLINT-CONVEYING APPARATUS. BERNARD GEORGE VAUGHAN, Joliet, Ill.

1,093,374. PRESSURE-EQUALIZER FOR ROTARY BLOWERS. OTTO BANNER, Sterkrade, Germany.

1,093,389. SUCTION APPARATUS. JOHN C. FORD, deceased, Keokuk, Iowa, by Mary E. Brown, administratrix, Keokuk, Iowa.

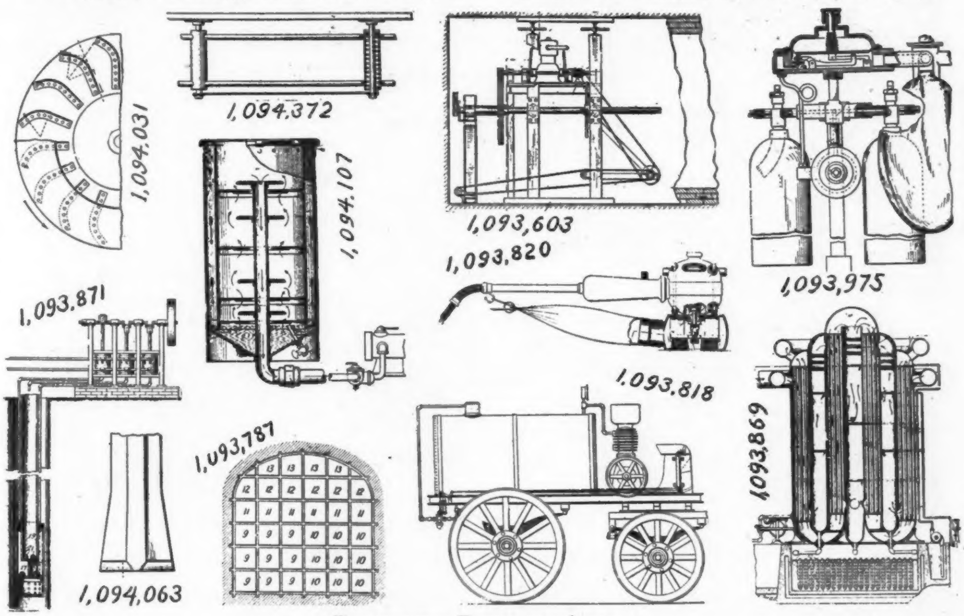
1,093,408. DRILL-CYLINDER. CHARLES C. HANSEN, Easton, Pa.

1,093,420. BLOWPIPE. CHARLES HOLDER, JR., New York, N. Y.

1,093,454. AIR-BRAKE APPARATUS. BLYTHE J. MINNIER, Watertown, N. Y.

1,093,546. PNEUMATIC VALVE. JUDSON ROGERS DE NOYELLES, Binghamton, N. Y.

1,093,551. SAND - BLAST APPARATUS. CHARLES A. DREISBACH, New Haven, Conn.



PNEUMATIC PATENTS, APRIL 21.

APRIL 21.

1,093,603. TUNNELING AND EXCAVATING MACHINE. CHARLES H. BONNETT, Port Huron, Mich.

1,093,613. AIR-COUPLING DEVICE. RUDOLPH GEISER, Toledo, Ohio.

1,093,787. METHOD OF TUNNELING. HARRY A. KUHN and WALTER W. MACFARREN, Pittsburgh, Pa.

1. A method of tunneling comprising the following steps: 1st, forming simultaneously a number of intersecting slots or channels in one half of the "head;" 2nd, forming simultaneously similar slots or channels in the other half of the "head" and at the same time removing the material previously cut, and the material between said previous cuts in the first half of the "head," and so on alternately *"ad libitum."*

1,093,818. ROAD-OILING VEHICLE. GEORGE I. WORLEY, Kansas City, Mo.

1,093,820. VACUUM-CLEANER. CHESTER H. BEACH, Racine, Wis.

1,093,859. METHOD OF DRYING AIR FOR BLAST-FURNACES. MARK W. JOHNSON, JR., Birmingham, Ala.

1. The method of drying air which consists in compressing the air, cooling it to condense the moisture contained, removing the condensed moisture, and then heating the air by bringing it into heat interchanging relation with the compressed air before the latter is cooled.

1,093,869. APPARATUS FOR DRYING GASES. CHARLES H. LEINERT, Chicago, Ill.

1,093,871. COMPRESSED-AIR WATER-ELEVATOR. ROBERT SAFFORD MCINTYRE, Riverside, Cal.

1. A water elevating apparatus comprising a cylinder with inlet and outlet valves and adapted to be immersed in the water to be elevated, an air cylinder, a reciprocatory piston in the air cylinder, and an air conduit of relatively small capacity connecting one end of the air cylinder to the water cylinder, the air cylinder being void of valves and having ports between its interior and exterior at that end only of the stroke of the piston remote from the end of the air cylinder connected to the water cylinder, and the water cylinder being provided with a balancing passage between its interior and exterior.

1,093,975. ANESTHETIZER. GRAHAM CLARKE, Cleveland, Ohio.

1,093,989. LOCOMOTIVE-SAND-BOX ARRANGEMENT. CHARLES L. HEISLER, Schenectady, N. Y.

1,094,031. CENTRIFUGAL FAN. FREDERICK R. STILL, Detroit, Mich.

1,094,063. ROCK-DRILL BIT. CARROLL R. FORBES, Rolla, Mo.

1. A radial wing drill bit having its wings tapered longitudinally, the said wings being flattened at their ends adjacent their outer edges.

1,094,107. AIR-WASHER. ALFRED WICKERSHAM, Sunnyvale, Cal.

1,094,195. PROCESS FOR DRYING PAPER. EDWARD P. BUTTS, Springfield, Mass.

The process of drying paper with air having a predetermined moisture absorbing capacity, which consists in first effecting the saturation of the air by direct contact with water having a definite temperature, then directing the saturated air against an obstruction to separate therefrom the surplus of water, then directing the air against a heated surface having a definite temperature to effect the expansion of the air, next liberating the dried and heated air and causing it to pass over the paper to be dried, and finally collecting the moisture laden air to again be saturated and used as herein stated.

1,094,351. PNEUMATIC VALVE MECHANISM. WILLIAM ARTHUR WATSON, Malden, Mass.

1,094,372. AUTOMOBILE PNEUMATIC SPRING. ABI MAYERSON, Pueblo, Colo.

APRIL 28.

1,094,450. MASSAGE APPARATUS. HERBERT E. MARCY, Mount Vernon, N. Y.

1,094,521. AIR-FILTER. MAX BRAUER, Berlin-Wilmersdorf, Germany.

1,094,522. FLUID-MOTOR OR THE LIKE. LOUIS H. BRINKMAN, Glen Ridge, N. J.

1,094,540-1. FAN. CHARLES H. J. DILG, New York, N. Y.

1,094,567. PNEUMATIC SPRING FOR VEHICLES. JOSEF HOFMANN, Baumaroche, Switzerland.

1,094,579. VACUUM CLEANING-TOOL. FRANK J. MATCHETTE, Milwaukee, Wis.

1,094,592. AIR-MOISTENING APPARATUS. CARL HEINRICH PROTT, Rheydt, Germany.

1,094,808. PNEUMATIC PLAYER-ACTION. GUSTAF W. PAULSON, Belmont, and RUDOLF PAULSON, Boston, Mass.

1,094,943-4-5. AIR-BRAKE SYSTEM. JACOB RUSH SNYDER, Pittsburgh, Pa.

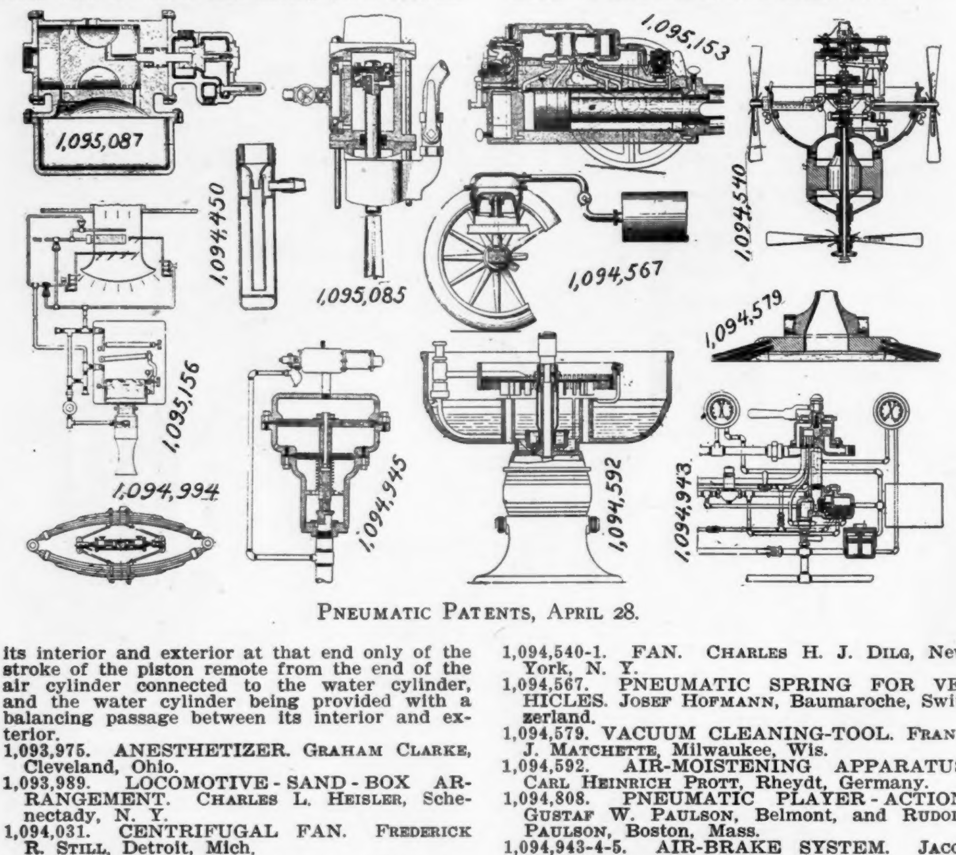
1,094,994. AIR-COMPRESSOR. FLOYD E. HUFFORD, Milford, Ill.

1,095,085. DRILL. JOHN THOMAS CURNOW, Palatka, Mich.

1,095,087. AIR-BRAKE APPARATUS. WILLIAM R. DAVIS, Columbus, Ohio.

1,095,153. DIRECT-ACTING ENGINE. ALBERT BALL and THOMAS OFFICER, Claremont, N. H.

1,095,156. APPARATUS FOR CONTROLLING THE HUMIDITY AND TEMPERATURE OF AIR. WILLIS H. CARRIER, Buffalo, N. Y.



PNEUMATIC PATENTS, APRIL 28.